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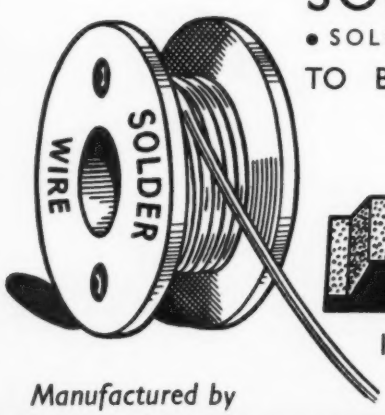

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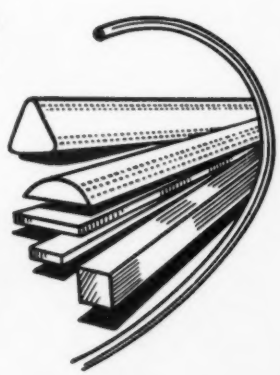

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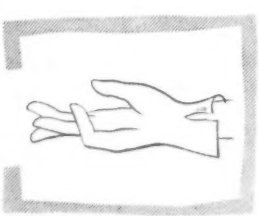

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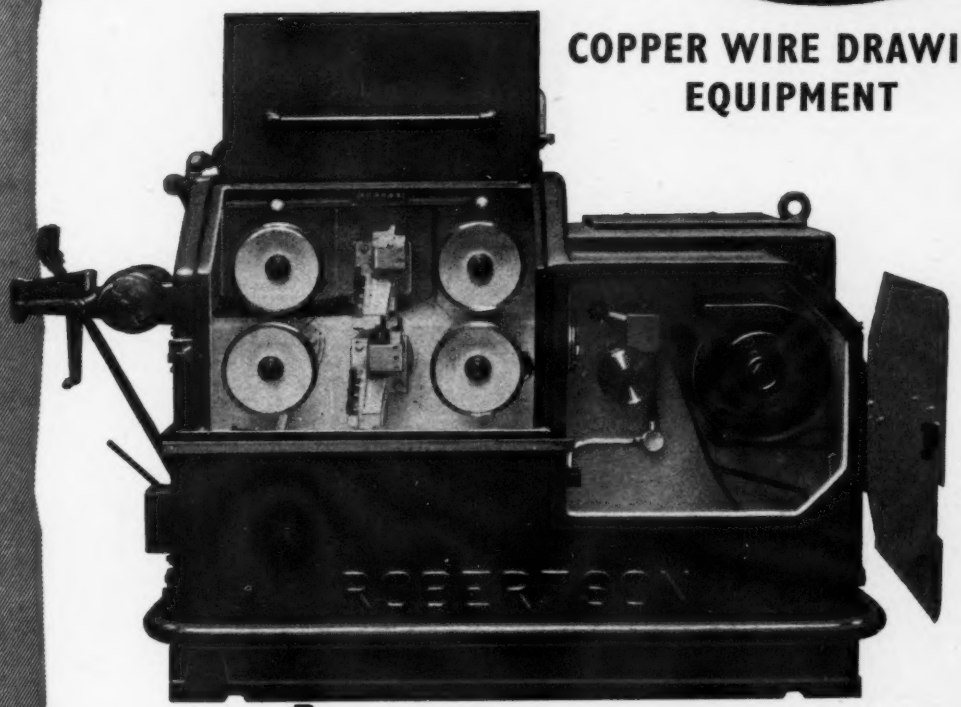

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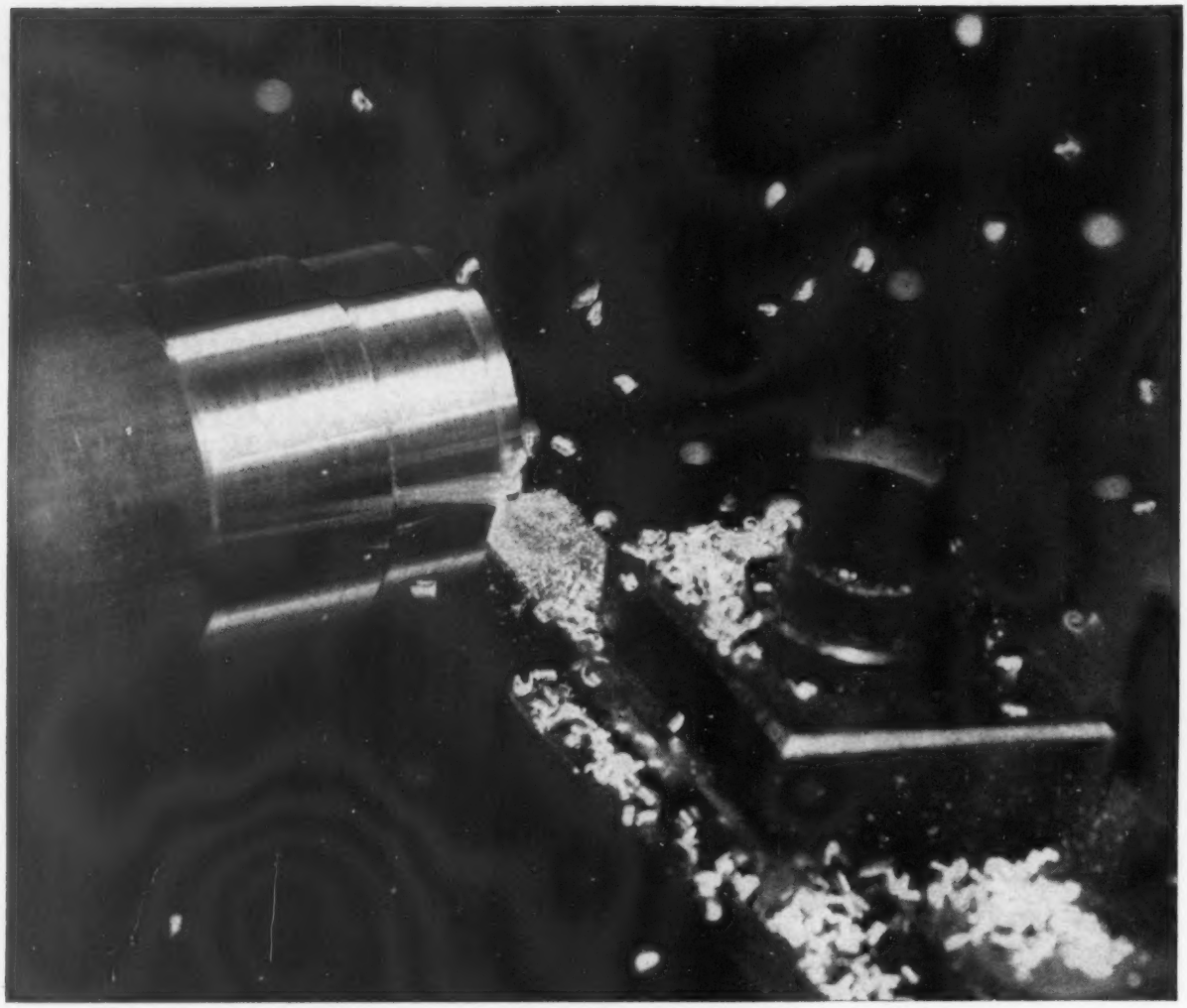

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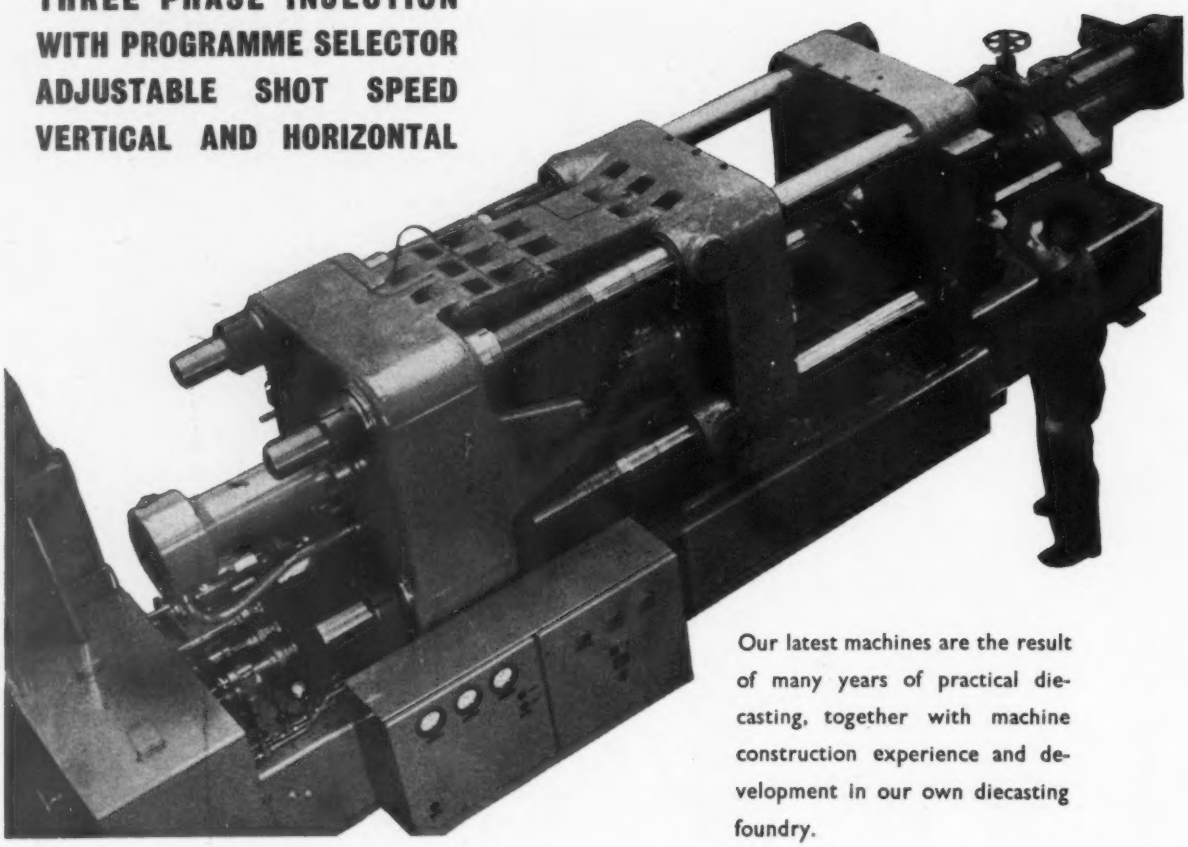

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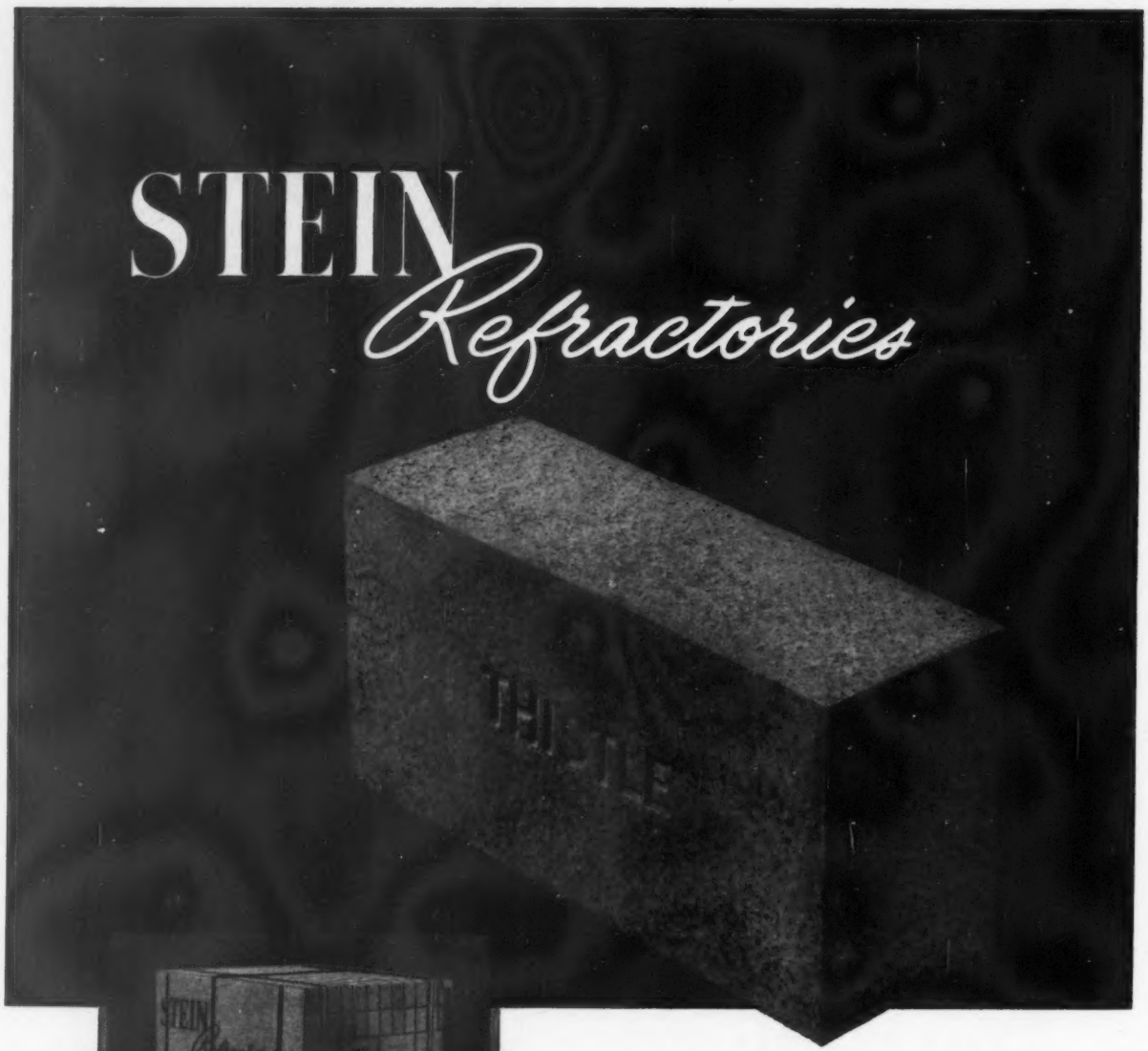

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# METAL INDUSTRY

FOUNDED 1909

EDITOR: L. G. BERESFORD, B.Sc., F.I.M.

19 JUNE 1959 VOLUME 94 NUMBER 25

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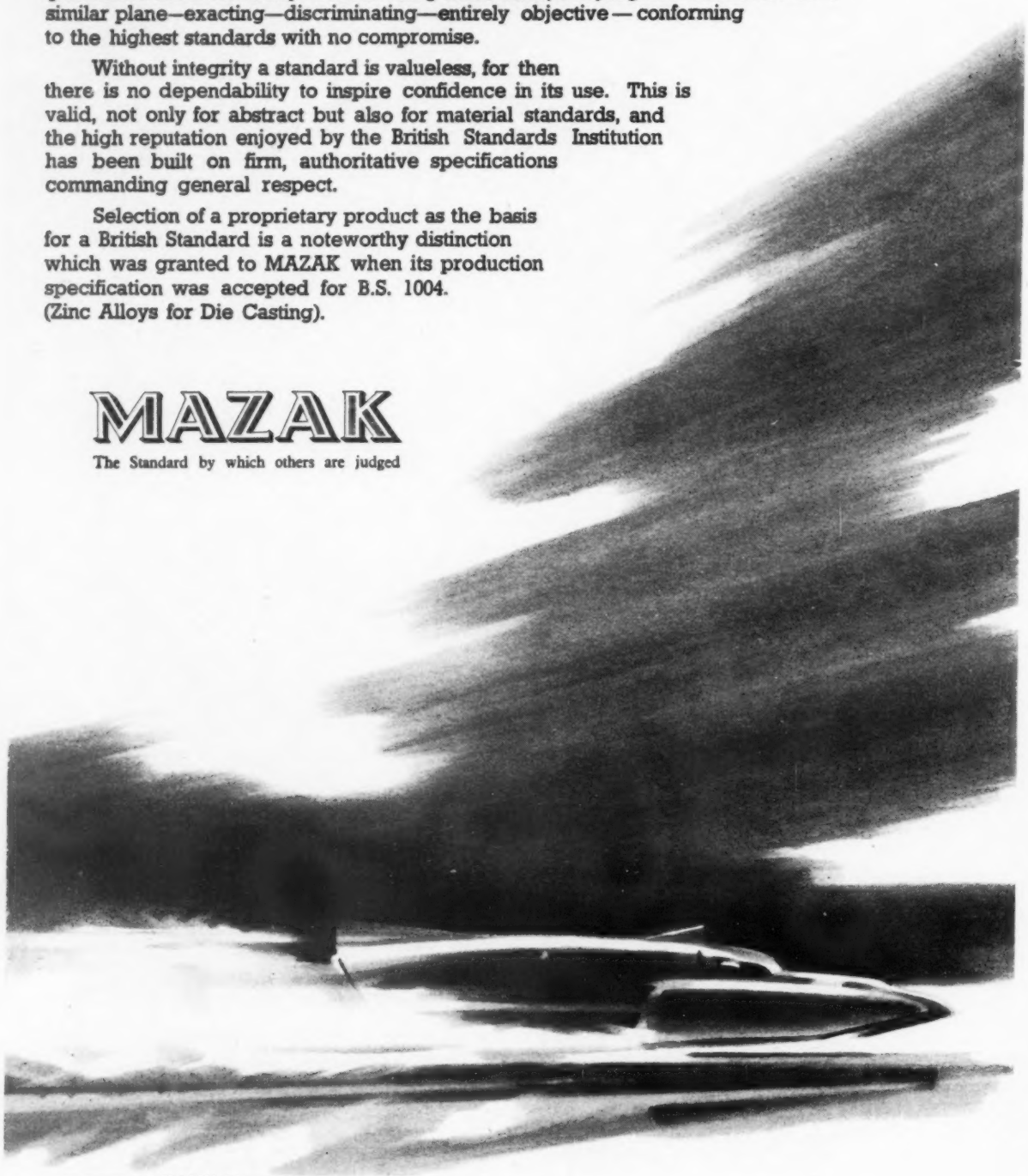

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# Industrial Trends

WAY back in February 1958, the Federation of British Industries instituted its first enquiry into current industrial trends, and has continued this practice at regular intervals. The results of the latest enquiry (the fifth), made at the beginning of June 1959, have recently been made available. The report is based on replies received to a standard questionnaire from some 700 firms which are representative of British industry both in size (the firms chosen being fairly evenly divided between those employing up to about 200 and over 2,000 workers) and type of output. Of these firms, 37 per cent are engaged in the metals, engineering, shipbuilding and electrical industries, and a further 9 per cent in the manufacture of motor cars, tractors, aircraft, rolling stock or parts for the same, and may, therefore, be regarded as typical of the metal-producing and metal-using industries. The remainder cover textiles, clothing, footwear, food, drink, tobacco, chemical, petroleum, building materials, paper, printing and miscellaneous. The basis of comparison for most of the replies in the current enquiry is provided by the report (the fourth) made at the beginning of February this year.

The outstanding feature of the results of this enquiry is an all-round improvement in the industrial situation as compared with four months ago. There is a general feeling of more optimism, 59 per cent of the respondents being more optimistic and only 4 per cent less so. With regard to the labour situation, 65 per cent report that it remains about the same but 22 per cent find it easier to get the labour they want. One-quarter of the firms state that the average weekly hours worked per operative and the numbers employed are greater, 11 per cent and 16 per cent reporting them respectively to be lower. Excluding seasonal factors, the present level of output is reported by 46 per cent of the firms to be greater than in February last, so that 38 per cent of them are working to capacity; 60 per cent, however, state that they are still working below capacity, although only 12 per cent have more unused capacity than four months ago.

Nearly half the replies indicate that orders are coming in at a greater rate, only about one-eighth reporting declines compared with February. In that month there were signs of weakness in the trend of export orders, but this ominous trend has now been reversed, 27 per cent reporting an increase and only 19 per cent a decrease in these orders. The level of export deliveries remained the same for 42 per cent and was higher for 26 per cent of the firms, but home deliveries were up in the case of 49 per cent and only 12 per cent reported a decrease. Length of order books show an increase in 32 per cent and remain the same in 37 per cent of the replies. The feature of previous enquiries has been the indication of continually falling stocks of raw materials. This time the decline is hardly significant. Work in progress and stocks of finished goods are reported to remain the same as in February last by 43 per cent of the firms, but have respectively increased for 34 per cent and 24 per cent.

Two major features are in contrast. Although costs are steadying (52 per cent of the replies indicating them to be the same as in February last), selling price reductions outweigh price increases, and in consequence a majority report that profit margins have fallen. Capital investment is not sharing in the general expansion. Thus, 36 per cent of the firms do not expect to authorize for purchase more plant and machinery in the next twelve months than in the twelve months past, and 31 per cent anticipate authorizing less. On buildings, 37 per cent of the respondents expect to spend less, and only 23 per cent more, in the ensuing year.

# *Out of the* MELTING POT

**Natural**

IN the days before science had been admitted to the foundry, the various processes involved in the casting of metals provided a ground in which trade secrets, secret recipes, tricks of the trade and the like, grew and flourished exceedingly. Scope was provided by the wider use of naturally-occurring raw materials, and human nature being what it is, successful results tended to be linked with the use of the more unusual and more exotic of such raw materials, with, fortunately, no scientific tests and no results of quality control methods to gainsay the belief in their efficacy. In spite, however, of the triumphant advance of the synthetic—from sand to resins—a few natural materials (loam, straw, flour, molasses, sawdust, etc.) are here and there still to be found. Neither, it seems, have inventors completely abandoned the naturally occurring raw materials, or products derived from them, in favour of the scientifically synthetic. What relief, for example, to come across an inventor who has discovered a new composition of matter for forming foundry moulds and cores of the type consisting of sand mixtures with organic cellulose carbonaceous additives, which composition is superior in many respects to compositions previously used, and then to learn that these mixtures do not depend on yet another hardly pronounceable polymer and are not specifically intended to permit the use of still more highly mechanized methods of preparation and moulding. What a relief to learn that the moulding composition comprises an unreacted intimate mixture of (1) a foundry sand mixture and (2) a mixture consisting essentially of ground powder of corncob beeswing, ground powder of corncob outer glume and ground powder of corncob pith. This mixture is prepared by crushing corncobs; separating and discarding substantially all of the hard woody ring portion thereof; and grinding the outer glume, beeswing and pith portions thereof to a powder of a fineness of about 40-50 mesh. This mixture is added to the foundry sand mixture in the proportion of from 1 to 10 per cent.

**Terms**

RAPID advances in all branches of science and technology have outdistanced most of the few existing arrangements for coining names for materials, processes, effects, phenomena, etc., that are being discovered all the time. In view of the pressing demands for nomenclature to meet the requirements of current discoveries, it is hardly surprising that little attention is given to existing situations. It is only on rare occasions that somebody can find the opportunity to take stock of an existing situation and to proceed to explain, for instance, that "a study of certain special materials, such as the catalyzing cermets, has led him to apply the new term 'catallurgy' to the catalytic effects in metallurgy. Catallurgy concerns itself with the sum total of theories, empirical work, and processes relating to heterogeneous catalyses, but only with reference to the solid phase (contact mass). This branch of metallurgy appears to comprise two main subdivisions. 'Ceramallurgy' is concerned with the choice of simple natural materials with a metallic or ceramic base, or with the preparation of composite materials and their behaviour as contact masses. 'Affinallurgy' concerns itself with the refining of molten metallurgical products by the introduction of substances which act as catalysts, that is to say, substances which remain unchanged at the end of the process." Whatever may be thought of the actual terms, one cannot but sense the merit of the almost "olde-worlde" attempt, which follows the above introduction, at unifying the knowledge accumulated within the widely staked definitions of the above terms. Unfortunately, such merit is likely to remain without a general recognition and without a reward in these days of a real interest confined to progressively smaller fields of knowledge.

**Less Obvious**

AS science advances, opportunities of explaining the obvious in terms of the less obvious become more numerous. In some cases this process may be carried to a degree at which the less obvious completely replaces the obvious. There was the case of the meteorologist who explained that a particularly obnoxious smog was due to a temperature inversion: a situation in which, due to the presence of two different air layers that fail to mix, the temperature at a certain height is higher than that of the layer of air nearer the ground and, consequently, the usual convection currents are absent. The obvious explanation that the smog was due to smoke belching from factories, power stations and domestic chimneys, and to exhaust fumes from motor vehicles, was completely overlooked. One is reminded of this tendency towards the less obvious explanations by a brief report of some preliminary tests on the fatigue properties of ternary aluminium-zinc-magnesium alloys. The investigation was prompted by the explanation that the poor fatigue properties of age-hardened aluminium alloys are due largely to the metastable nature of the dispersed precipitate. The localized deformation caused by cyclic stressing causes such a precipitate to become unstable, the resulting localized softening leading to further concentration of deformation, and so on. The softening itself is thought to be associated with dislocation movements in the regions concerned. The investigation was intended to determine whether the presence of magnesium atoms in excess of the number required for the age-hardening mechanism in the aluminium-zinc-magnesium alloys would interfere with such dislocation movements, as solute atoms do, and, therefore, improve the fatigue strength of these alloys. Fatigue tests on a number of alloys having a range of increasing values of the magnesium: zinc ratio, but all heat-treated to approximately the same tensile strength, did show that the fatigue strength did, in fact, tend to increase with increasing magnesium: zinc ratio. The matter was not, however, as simple as that. In particular, evidence was obtained of the existence of a critical magnesium: zinc ratio for which the fatigue strength is a maximum. Further work will be necessary to show whether the explanation based on the interaction of dissolved magnesium atoms with dislocations is tenable or whether some less obvious explanation will have to be given.

Skinner

PREDICTING ALLOY PROPERTIES FROM BASIC THEORETICAL CONSIDERATIONS

# Tailor Made Alloys

By D. A. ROBINS, B.Sc., Ph.D., A.Inst.P., A.I.M.

*At the Spring Meeting of the Institute of Metals, one of the technical sessions dealt with the practical aspects of metal physics, and among the contributions was the article published here. It discusses the fundamental theory of the structure of metals and indicates how theoretical knowledge may be of practical value in the formulation of alloys.*

ON occasions, the term "tailor made alloys" has been applied to the preparation of alloys to precise specifications such as, for example, the preparation of alloys by powder metallurgy having accurately controlled expansion characteristics. This use of the phrase "tailor made alloys" will be excluded completely from the considerations here. What will be considered is how far developments in understanding of the properties of the metallic state can be applied to the development of new or improved alloys. In other words, how far is it possible at the present time to predict the properties of an alloy from theoretical considerations? It will be necessary to bear in mind that basic knowledge can be of potential value in two different ways:—

(i) It may be of direct value in the development of commercial alloys; or (ii) it may be a guide in the planning of experimental work directed towards the development of new or improved alloys.

Some of the topics which come under this heading have had to be excluded and, in general, specific examples are given to illustrate general principles rather than attempting to present an exhaustive catalogue. The physical properties of alloys are not considered in any detail and a number of important topics, such as, for example, oxidation and corrosion resistance, have been excluded. The practical value of a basic theoretical approach to the understanding of metals is considered first and then secondly, a rather less basic approach, making use of semi-empirical rules, is briefly considered.

## Fundamental Theory

Under the heading "fundamental theory" the present practical value of (a) the electron theory of metals and (b) lattice fault theory (dislocations, vacancies etc.) may be considered.

*The Electron Theory of Metals.* The collective electron theory aims at understanding the character and properties of a metal from a knowledge of the characteristics of individual atoms of which the metal is composed and, from an aesthetic point of view, this approach is, perhaps, the most satisfying. The behaviour of the comparatively free electrons present in the metal is expressed in terms of wave equations and the results of the application of quantum theory and wave mechanics to metals are well known to most metallurgists, at least in fairly general terms; the Institute of Metals in the Monograph and Report series published a very good introduction to the subject by Professor Raynor.

For monovalent metals (the alkali metals and copper, silver and gold) electron theory has had considerable success in interpreting the extent of solid solution ranges in binary alloys and the occurrence of intermediate compounds of specific crystal structure at particular electron/atom ratios (the so-called Hume-Rothery electron compounds). For example, from Brillouin zone considerations it can be shown that the crystal structure of the monovalent element copper will become unstable when an electron concentration of approximately 1·4 electrons/atom is reached so that the solubility of a divalent or tri-valent element in copper will only extend up to this electron concentration (40 at. per cent for a divalent element and 20 at. per cent for a tri-valent element) even when the size factor is favourable. This is in agreement with experimental results; copper, for example, will dissolve 30 to 40 at. per cent of divalent zinc depending on temperature but only 15 to 22 at. per cent of tri-valent gallium (Table I). It can be seen from the Table that in certain cases size factor and electron concentration are not the only considerations and by the time the theory had been developed most of the binary diagrams to which the theory could be applied, had already been determined. The theory is of some value, however, as a guide to the development of ternary and more complex alloys based on the monovalent metals.

Although electron theory had considerable success in its application to the physical properties and alloying behaviour of monavalent metals, the complexities which are introduced when considering metals of higher valency has, so far, seriously limited its usefulness. For these higher valency metals the electron theory has mainly been employed in conjunction with experimental work to try to assess the effect of such complicating factors as difference in electro-negativity and differences in atomic diameter between solute and solvent.

It may be stated that, in general, the collective electron theory can be of some value in planning experimental work on monovalent metals and, to a limited extent, on bivalent metals but its practical value at the present time is severely limited. The truth of this statement can be seen from the technological development in recent years of such metals as titanium, zirconium and niobium. The development of useful alloys based on these elements (where it has not been entirely empirical) has been based on semi-empirical relationships and the collective electron theory has been of little value. This, of course, emphasizes the complexity of the transition metals (elements in which the *d*-electrons take part in the bonding process) and, for these complex elements there seems little likelihood of the theory being developed sufficiently for it to be of practical value in alloy development for many years.

*Lattice Fault Theory.* In contrast to electron theory which has progressed slowly in recent years, lattice fault theory has progressed rapidly. Whereas only ten to fifteen years ago we did not know in any detail what atomic re-arrangements were taking place within a metal during plastic deformation the picture now, although by no means complete, is firmly established in terms of the

**TABLE I—MAXIMUM SOLUBILITY IN COPPER, SILVER AND GOLD OF ELEMENTS WITH FAVOURABLE SIZE FACTORS**

| Alloy System | Valency of Solute | Electron Atom Ratio | Alloy System | Valency of Solute | Electron Atom Ratio |
|---|---|---|---|---|---|
| Ag – Cd | 2 | 1·43 | Au – Cd | 2 | 1·33 |
| Ag – In | 3 | 1·40 | Au – Al | 3 | 1·31 |
| Ag – Al | 3 | 1·40 | Au – Zn | 2 | 1·30 |
| Ag – Zn | 2 | 1·40 | Ag – Sb | 5 | 1·29 |
| Cu – Al | 3 | 1·40 | Cu – As | 5 | 1·27 |
| Cu – Ga | 3 | 1·39 | Au – In | 3 | 1·26 |
| Cu – Zn | 2 | 1·38 | Au – Sn | 4 | 1·21 |
| Cu – Ge | 4 | 1·34 | Au – Hg | 2 | 1·20 |
| Ag – Sn | 4 | 1·34 | Au – Sb | 5 | 1·05 |

behaviour of dislocations. The time for "dis-believing in dislocations" is past and the time is rapidly approaching when practising metallurgists ignore at their peril the understanding of the properties of metals which lattice fault theory has made possible. Knowledge of the behaviour of dislocations and vacancies is being used as a guide in the planning of experimental work and it has already contributed to the development of better materials. It is not intended here to try and summarize the present position of the theory but, rather, to indicate the spheres where it can be and is being used.

One of these fields is in the development of alloys for high temperature service. To reduce the creep rate of an alloy at elevated temperatures the movement of dislocations under stress must be kept to a minimum. Dislocation movement can be made more difficult by the presence of elements in solid solution (solution hardening) but at high temperatures where self-diffusion becomes rapid it seems unlikely that dislocation movement will be retarded to any great extent by this mechanism. This is borne out by experience. The interaction of dislocations will also produce hardening (work hardening) but again self-diffusion will produce recovery at elevated temperatures. The creep resistance of the present high temperature alloys is largely dependent on precipitation hardening in which the precipitated phase is a barrier to dislocation movement. As has been pointed out by Cottrell, however, it is not clear whether the low creep rate of commercial alloys is due to precipitation hardening prior to stressing or whether the effective precipitation is taking place during deformation. In practice, the alloys are solution treated and then aged at a lower temperature in order to produce some precipitation. Deformation accelerates ageing, however, and further precipitation may be taking place during service and Cottrell has suggested that the climb of dislocations over a barrier is likely to be retarded if precipitation is taking place along the dislocation line during the deformation process. He suggests,[1] therefore, that "the greatest creep resistance should be obtained by using two distinct precipitating substances, one already precipitated before the creep deformation, in order to raise the initial elastic limit and reduce initial creep, and one held back in (slightly) supersaturated solution, ready to precipitate in dislocations and prevent them from climbing." Here, then is a prediction which can be the basis for the development of new alloys. In a most interesting Paper by Glen[2] which discusses in some detail the effect of alloying elements on creep behaviour, evidence is found for strain-induced precipitation in commercial alloys during creep.

Another sphere in which lattice fault theory is likely to be of practical value is in helping to understand the effect of interstitial elements such as carbon and nitrogen on the mechanical properties of metals with the body-centred-cubic crystal structure. The original interpretation of the presence of a yield point in iron in terms of the locking dislocations by interstitial atoms (the so-called Cottrell locking) has been developed and supported by experimental work. The locking of dislocations is responsible for the well-known effect of temperature on the yield point of body-centred-cubic metals. Decreasing the temperature of test increases the yield strength until the yield strength exceeds the fracture strength and a brittle fracture is obtained. The temperature of this ductile to brittle transition, which is found in, for example, α iron, molybdenum and tungsten, varies, of course, with the conditions of test and the state of the metal and it can be of considerable practical importance. For example, the usefulness of an element such as molybdenum as the major constituent in an engineering material has been limited by the room temperature brittleness of molybdenum in the recrystallized state. A large amount of experimental work has been carried out, both in this country and in America, to study the effect of trace impurities on the ductile to brittle transition temperature of molybdenum. It is, perhaps, fair to say that, had dislocation theory not been developed, it might have been concluded from the

**TABLE II—ELECTRO-NEGATIVITIES OF ELEMENTS**

| Atom | Single-bond Covalent Radius $r$ | Valence Electrons $n'$ | Electro-Negativity* $x$ | $0{\cdot}31\left(\frac{n'+1}{r}\right)+0{\cdot}5$ |
|---|---|---|---|---|
| Ag | 1·53 | 1 | 1·9 | 0·91 |
| Al | 1·26 | 3 | 1·5 | 1·48 |
| As | 1·21 | 5 | 2·0 | 2·04 |
| Au | 1·50 | 1 | 3·1 | 0·92 |
| B | 0·88 | 3 | 1·9 | 1·91 |
| Ba | 2·17 | 2 | 0·9 | 0·93 |
| Be | 1·06 | 2 | 1·45 | 1·38 |
| Bi | 1·40 | 5 | 1·8 | 1·83 |
| Br | 1·14 | 7 | 2·75 | 2·68 |
| C | 0·77 | 4 | 2·55 | 2·52 |
| Ca | 1·78 | 2 | 1·0 | 1·03 |
| Cd | 1·48 | 2 | 1·1 | 1·13 |
| Cl | 0·99 | 7 | 2·97 | 3·00 |
| (Cr) | 1·25 | 6 | (2·2) | 2·24 |
| Cs | 2·25 | 1 | 0·75 | 0·78 |
| Cu | 1·35 | 1 | 2·2 | 0·96 |
| F | 0·72 | 7 | 3·95 | 3·94 |
| Ga | 1·26 | 3 | 1·4 | 1·48 |
| Ge | 1·22 | 4 | 1·7 | 1·77 |
| H | 0·37 | 1 | 2·13 | 2·17 |
| Hg | 1·50 | 2 | 1·0 | 1·12 |
| I | 1·33 | 7 | 2·45 | 2·36 |
| In | 1·44 | 3 | 1·4 | 1·36 |
| K | 1·96 | 1 | 0·80 | 0·82 |
| (La) | 1·86 | 3 | (1·2) | 1·17 |
| Li | 1·34 | 1 | 0·95 | 0·96 |
| Mg | 1·40 | 2 | 1·2 | 1·16 |
| (Mn) | 1·18 | 7 | (2·6) | 2·60 |
| (Mo) | 1·36 | 6 | (2·1) | 2·09 |
| N | 0·74 | 5 | 2·98 | 3·01 |
| Na | 1·54 | 1 | 0·90 | 0·90 |
| (Nb) | 1·43 | 5 | (1·8) | 1·76 |
| O | 0·73 | 6 | 3·45 | 3·47 |
| P | 1·10 | 5 | 2·1 | 2·19 |
| Pb | 1·46 | 4 | 1·5 | 1·56 |
| (Po) | 1·46 | 6 | (2·0) | 1·98 |
| Rb | 2·11 | 1 | 0·78 | 0·79 |
| S | 1·04 | 6 | 2·53 | 2·58 |
| Sb | 1·41 | 5 | 1·8 | 1·82 |
| Sc | 1·61 | 3 | 1·3 | 1·27 |
| Se | 1·17 | 6 | 2·4 | 2·35 |
| Si | 1·17 | 4 | 1·8 | 1·82 |
| Sn | 1·40 | 4 | 1·7 | 1·61 |
| Sr | 1·93 | 2 | 1·0 | 0·98 |
| (Ta) | 1·31 | 7 | (2·4) | 2·39 |
| Te | 1·37 | 6 | 2·1 | 2·08 |
| Ti | 1·45 | 4 | 1·6 | 1·57 |
| Tl | 1·47 | 3 | 1·3 | 1·34 |
| (V) | 1·30 | 5 | (1·9) | 1·93 |
| Y | 1·75 | 3 | 1·3 | 1·21 |
| Zn | 1·31 | 2 | 1·2 | 1·21 |
| Zr | 1·58 | 4 | 1·6 | 1·48 |

* *Values given in parentheses are taken from the final column: others are derived in a manner independent of Gordy's equation.*

(*From Darken and Gurry, "Physical Chemistry of Metals" McGraw Hill, New York*, 1953).

results of the experimental work that recrystallized molybdenum is inherently of low ductility at room temperature. In other words, an understanding of the way very small percentages of interstitial elements can lock dislocations has made us appreciate the importance of trace impurities in body-centred-cubic metals and, therefore, has helped to guide the experimental work along the right lines.

The usefulness of lattice fault theory, is perhaps, most clearly seen in the field of atomic energy. The development of nuclear reactors has involved the use of materials under completely new service conditions. To assess the effects of radiation damage on the properties of a given material actual experimental tests must, of course, be carried out but the experimental facilities required for this sort of work are very expensive and are to a certain extent limited. It is of first importance, therefore, to plan the experimental work so that a maximum amount of information is obtained from the results. Consider, for example, the effect of neutron irradiation on the creep strength of a metal or alloy. For a pure metal the creep strength becomes poor when self-diffusion becomes rapid due to the increase in the concentration of thermal vacancies with increasing temperature. The effects of irradiation damage which produces point defects may be expected, therefore, to be related to the thermal effect. At high temperatures the number of thermal vacancies is large and, therefore, the additional effect of irradiation damage on creep rate is likely to be small. On the other hand at low temperatures, the reduced mobility of the vacancies will prevent them having an adverse effect; in fact some degree of hardening is to be expected. There should, therefore, be a critical temperature range over which the effects of irradiation on creep will be important. Again, if the creep strength of an alloy is dependent on the hardening produced by a fine precipitate (e.g. G.P. zones) then, under irradiation, the increased diffusion rates will produce over-ageing and, therefore, an alloy, to retain its properties under irradiation, should be hardened by elements in solid solution and/or by the presence of large stable precipitates.

It can be concluded that the main practical value of the theoretical advances has been in helping us to understand the behaviour of metals and alloys and of permitting at least some of the experimental work to be planned in the most economical way.

## Semi-Empirical Rules

The usefulness of a rather less basic approach can now be considered and brief reference must be made to the now famous Hume-Rothery relationships. In almost any of the accounts of the technological developments of the newer elements, such as titanium, alloying behaviour is considered in terms of these relationships.

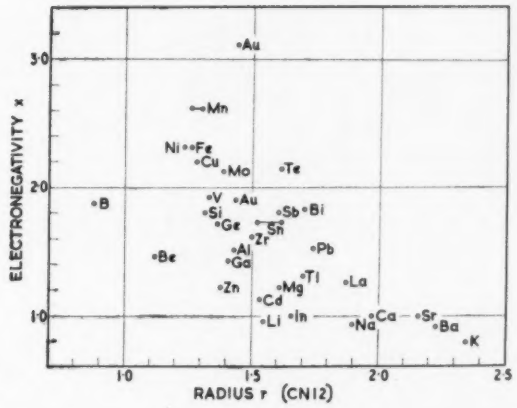



*Fig. 1—Diagram plotting electro-negativity against atomic radius*

*Hume-Rothery Relationships.* It was first pointed out in 1934 by Hume-Rothery and his co-workers that a necessary condition for an extensive solid solubility of one element in another is that the difference in atomic diameters of the two components should not be greater than 15 per cent. This rule has been used extensively as a first criterion for solid solubility and it is worth noting that when the size factor is unfavourable (i.e. greater than 15 per cent) the solubility usually increases with increasing temperature and such additions may be of value in producing precipitation hardening.

Experience has shown that a favourable size factor is not a sufficient condition for extended solubility and allowance must be made for differences in valency and electro-negativity. In copper, silver and gold the solubility of a second element is likely to be lower the higher its valency and, as has already been seen this is in keeping with electron theory. When both metals are of valency greater than one the situation is more complex however. There will be a tendency for the formation of intermetallic compounds when the difference in electro-negativity between the two elements is large thereby limiting the solid solution range even when the size factor is favourable.

Pauling has shown that it is possible to prepare a numerical table of electro-negativities in such a way that the square of the difference in the electro-negativities of two elements is approximately proportional to the heat evolved during the formation of a bond between these elements, and Gordy showed in 1946 that these electro-negativity values could be expressed by the relationship:—

$$\text{Electro-negativity} = 0{\cdot}31\left(\frac{n'+1}{r}\right) + 0{\cdot}5$$

where $n'$ is the number of valency electrons/atom, and $r$ is the single bond radius. (The single bond radius of a metal, introduced by Pauling, is an attempt to obtain a value for the radius of an atom which is independent of the strength of the interatomic bonding forces. It is defined by the equation:—

$$r - r_n = 0{\cdot}3 \text{ Log } n.$$

where $n$, the bond number, is the number of sharing electron pairs making up the bond in which the metal radius is $r_n$. That is $n$=the co-ordination number divided by the metal valency.)

Some values of Pauling's electro-negativities are given in Table II together with values calculated from Gordy's equation. These values will not be considered in detail but the Table makes it clear that a quantitative guide to differences in electro-negativity is available. In general, experience has shown that compound formation will prevent extensive solid solubility in a binary system when the difference in electro-negativities between the two elements is greater than about half a unit. If, therefore, the elements are plotted on a diagram in which one axis represents atomic radius and the other represents electro-negativity there will be a region around any given element for which extensive solid solubility is possible and for elements outside this area extensive solubility is unlikely (Fig. 1). The ability to predict the solid solubility range in alloys is of obvious practical importance although it should be emphasized that these relationships must be used with caution.

*Intermetallic Compounds.* When considering the use of intermetallic compounds in dispersed phase hardening, for example, a knowledge of their stability under given conditions is required. If thermodynamic data are available, therefore, this data can be a guide to the experimental work. For this reason the interesting correlation by Kubaschewski of the stability of intermetallic phases should be mentioned. This is a new work which was presented by Kubaschewski at an N.P.L. Symposium last June. Making use of two simple assumptions, Kubaschewski has calculated what he calls an effective co-ordination number for the two types of metal atoms in a given intermetallic compound. From

these effective co-ordination numbers (referred to here as co-ordination factors) he has been able to calculate the heat of formation of a large number of compounds of different crystal structures. He has then compared these calculated values with known heat of formation data and has obtained a remarkable degree of agreement. His co-ordination factors do not necessarily bear any relation to actual co-ordination since they include an allowance for changes in bond length brought about by alloying. For example, a face-centred-cubic metal in which the metal atoms have a co-ordination number of twelve will have, using his relationships, a co-ordination factor greater than twelve if all the bond distances are reduced. The co-ordination factor does take into consideration, therefore, bond energies as well as the geometry of the crystal system and this, presumably, is the reason why the correlation is possible. The value of the correlation is that it can be used to estimate the stability of an intermetallic compound of known crystal structure when experimental data are not available. How far metallurgists will make use of Kubaschewski's ideas will have to be seen.

*The Transition Metals.* All the metals with high melting points are transition metals, and, therefore, the transition metals are of considerable practical importance. Any basic understanding of their properties is difficult, however, owing to their complex electronic structure in which the *s* and *p* states of the outer electronic shell overlap those of the incomplete *d* shell forming hybrid *spd* bonding orbitals and, as has been seen, the collective electron theory cannot as yet be applied, with any measure of success, to these metals. The writer's own interpretation of some of the properties of the transition metals, which claims to be consistent with the known facts, and which can be used to predict the behaviour of transition metal alloys and interstitial compounds may now be considered. The interpretation is based upon the resonating covalent bond theory of Pauling and its subsequent modifications by Hume-Rothery, Irving and Williams.

Hume-Rothery and his co-workers[3] have suggested a scheme for the valencies of the transition metals in which the valencies in the metallic state are considered to be related to the valencies exhibited by these elements in inorganic chemistry. The valencies of the Group IIIA, IVA, VA and VIA elements are considered to increase progressively from three for the Group IIIA elements, four for the Group IVA elements, five for the Group VA elements and approximately six for the Group VIA elements. On moving farther to the right in the Periodic Table, at least for the second and third transition series, the valency of the elements is considered to decrease progressively owing to the additional electrons entering non-bonding orbitals and having coupled with them, electrons which previously contributed to the metallic bonding. In the first transition series the picture is more complex due to the increased stability of non-bonding orbitals and for this reason the writer's approach cannot be applied directly to elements in the first transition series beyond chromium.

The important feature of this picture of the valencies of the transition metals in relation to the writer's interpretation of their properties is that the addition of electrons to Group IIIA, IVA or VA elements will increase the number of bonding electrons, whereas the addition of electrons to the Group VIA elements, and those further to the right of the Periodic Table, will produce a decrease in the number of electrons available for resonating covalent bonding.

For the transition elements a maximum in the strength of the bonding forces is found in Group VIA of the Periodic Table as can be seen from the melting points and heat of formation data, and Hume-Rothery and his co-workers have put forward a possible explanation for this. According to the resonating covalent bond theory of metals the energy of a metal crystal is dependent both on the strength of the electron bonds and on the stabilizing effect of electron resonance. If the number of bonding electrons per atom is $V$ and the co-ordination number of the metal atoms is $N$, then the contribution of resonance will be a maximum when $V = \frac{N}{2}$ In face-centred-cubic metals and hexagonal-close-packed metals of ideal $c/a$ ratio, the co-ordination number is twelve and, therefore, for these crystal structures a maximum in the bonding energy is to be expected when there are six bonding electrons per atom (i.e.) in Group VIA of the Periodic Table. The Group VIA elements possess the body-centred-cubic structure, however, in which each metal atom has eight nearest neighbours and six next nearest neighbours at a slightly greater difference. The maximum in bond energies in Group VIA can, therefore, be understood if the effective co-ordination of a body-centred-cubic structure is approximately twelve, the six next nearest neighbours being equivalent, as far as resonance is concerned, to four atoms at the shorter distance. The writer's interpretation assumes an effective co-ordination number of twelve for the body-centred-cubic structure and this is in keeping with Kubaschewski's picture, in which an effective co-ordination number of 11·8 is obtained for the body-centred-cubic structure when changes in bond strength are not included; when changes in bond strength are included Kubaschewski obtains values of a little over twelve for what are called here his co-ordination factors.

It is postulated that, in the transition metals towards the centre of the transition series where high metal valencies are possible (and therefore, conditions for maximum resonance are possible) the properties of these elements are largely dependent on the tendency for the number of bonding electrons per atom to be equal to half the effective co-ordination number. This is saying that for these elements the resonance contributions to the strength of the bond are of considerable importance in determining, for example, crystal structure and alloying behaviour.

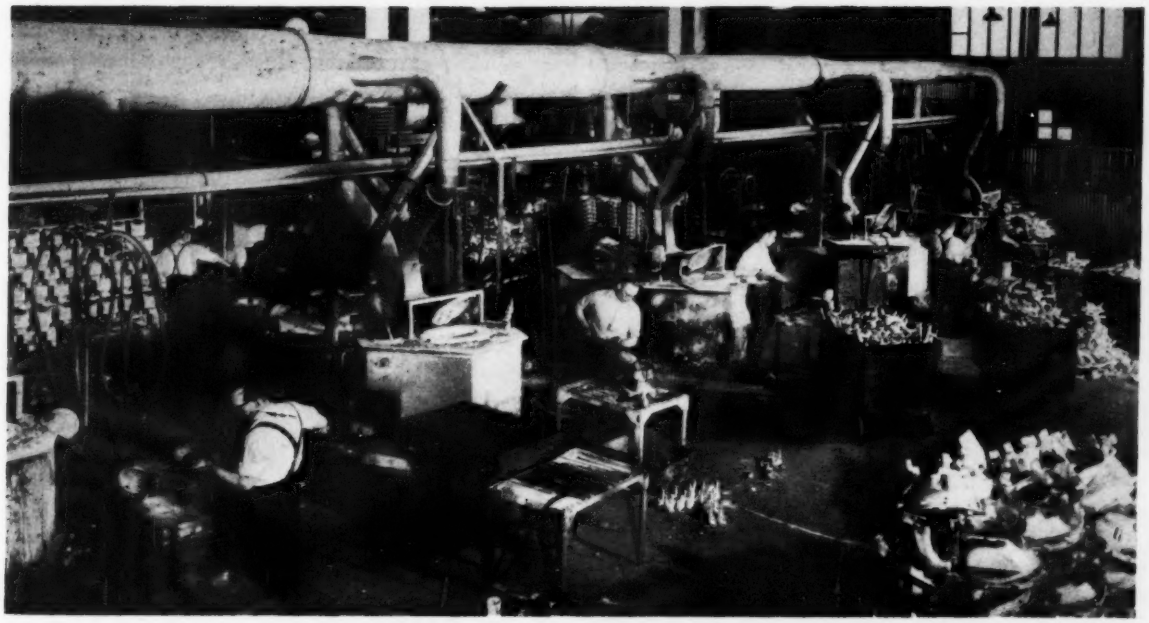
It cannot be shown here in detail, how this hypothesis can be applied to a wide range of properties of the transition metals, but for an example of the usefulness of this approach reference may be made to the first issue of "Powder Metallurgy" in which these ideas have been applied to the transition metal carbides. The interpretation is useful as a means of correlating the behaviour and crystal structure of binary alloys containing two transition metals and a considerable amount of experimental work to assess the practical value of this approach as a method of predicting the properties of alloys has been carried out at the Research Laboratories of the General Electric Co. Ltd., with remarkable success. It is intended to publish these results at the earliest opportunity. Only the passage of time will show how far this relationship between electron concentration and co-ordination number is generally useful, but it is believed that it will aid the development of "Tailor Made Alloys" based on the transition elements.

## Experience

Finally, one or two examples may be given of the way in which experience in a particular field of work can lead to empirical rules of limited application. For instance, there is the work of Kornilov and his co-workers in the field of high temperature alloys. From the results of creep tests at 800°C. on various binary, ternary and more complex alloys based on nickel, they conclude that the creep strength of this type of alloy increases progressively on increasing the number of components in the alloy. The same Russian school has shown that at low temperatures (600°-800°C.) the maximum effect of an addition element on the creep rate of nickel-base alloys is obtained when the solid solubility range is just exceeded whereas at high temperatures (e.g. 1,250°C.) maximum effect is obtained in an unsaturated solution. The observations are, of course based on experimental work and are not necessarily widely applicable but within a limited sphere they can be a guide in developing improved alloys.

It may perhaps have been noticed that, so far, no specific example of a "Tailor Made Alloy" has been given. It is in the field of experimental results

(*continued on page* 508)



*A general view of the gravity die-casting foundry at Kaye Alloy Castings Ltd., Handsworth*

# Die-Caster's Jubilee

ALTHOUGH there were indications of a revival in trade, it still needed courage to launch an industrial enterprise, however small, in 1934. That was the year in which Kaye Alloy Castings Limited was founded, and the glance back from this year's silver jubilee to the early years of the company emphasizes both the growth of the firm itself and some of the industrial trends that have developed.

In 1934, production was limited to a narrow range of gravity die-castings for automobile engine applications, and it was only gradually that the scope was widened. At that time the works occupied only a portion of the premises at Anne Road, Handsworth, where the present offices and gravity die-casting foundry are situated. As production expanded, however, and the market for die-castings developed, a beginning was made in the field of pressure die-casting, the first Kippcaster being purchased in 1938.

Early in the war years, when every effort was being made to increase production, a Schultz machine was installed, and since then the firm's pressure die-casting capacity has steadily increased. Throughout the war, gravity die-castings in aluminium alloys, aluminium bronze, and zinc were produced, but pressure die-castings were confined to zinc alloy.

In 1946, one of the major steps in the firm's history was taken, when the Presteigne (Radnorshire) works was acquired. This enabled plans to be put in hand for a much larger pressure die-casting programme, and at the same time relieved some of the pressure on space at the Handsworth works. At first, only the zinc pressure die-casting foundry was moved to Presteigne, but in 1949 an aluminium foundry was laid down and later extended by the addition of a further bay. The present equipment and capacity of the two works will be apparent from the following descriptions.

## Gravity Casting Foundry

The Handsworth premises consist of six bays, each 115 ft. long and 50 ft. wide, giving a total area of some 3,800 $yd^2$. At the east end of the works is the foundry, occupying two bays. Adjacent to this are core shops, with a machine shop, heat-treatment department, despatch department, offices, maintenance workshops and die store taking up the central area of the works. At the west end is the toolroom. A labour force of some 130 people is employed.

The foundry is laid out for melting and gravity casting any aluminium alloy in the commercial range used for gravity die-casting. A great deal of the foundry production is to D.T.D. specifications, and the company has been A.I.D. approved since 1936. The range of castings produced includes relatively small pieces of little more than half-an-ounce in weight, and others up to a half-hundredweight. Although aluminium bronze was cast until 1946, this has been dropped in order to concentrate attention on aluminium. A small amount of zinc is, however, still gravity cast.

Furnaces are of the bale-out type, varying from 300-400 lb. capacity. These are, as far as possible, retained regularly in use with a particular alloy in order to avoid any possible contamination of one melt by constituents of a different composition. When it does become necessary to melt different alloys in the same furnace, the practice of changing the crucible for each alloy is followed. In addition to the bale-out furnaces, of which there are twenty-four, a 400 lb. Berry tilting furnace is also employed for certain alloys. All furnaces are oil-fired, and fume hoods are fitted immediately above them, carrying smoke and fume via extraction ducting to a fan extraction system at one end of the shop. Further, to ensure comfortable working conditions, particularly in the hotter months of the year, an induction system brings fresh air into the foundry adjacent to the die-casting stands.

Prior to being issued for melting, ingot metal is received and stored at one end of the foundry. On receipt, it is clearly marked to indicate the type of alloy to which it belongs, so that casters themselves have no difficulty in ensuring that the right alloy is used.

The gravity die machines vary in size and type to correspond with the wide range of castings produced. Some are designed for manual operation, some are air-operated; there are also air-operated hoists for handling the larger dies and cores.

Maintenance of quality in the cast-

*Above : One of the gravity die machines with power-assisted corepullers*

*Left : One of the gravity dies ; in this case the die comprises a number of segments around a central core*

ings and reduction to a minimum of foundry scrap are achieved by having a patrol inspector, who examines three or four times each day, the castings coming from each of the dies. Any diminution in surface finish, inadequate feeding, or other defects, are thus located on the foundry floor, and steps are immediately taken to put the matter right.

The introduction, a few years ago, of shell-moulded cores constituted a major step forward in gravity die-casting, and although at this foundry a few sand cores are still made, the majority are shell blown. Core making machines are of Polygram design, and some typical cores may be seen in the illustration below. Many of the more intricate castings, such as the turbine in which 28 segments are used, would be economically impracticable without the use of shell-blown cores.

There still remains, however, a number of castings in which the hand moulded sand core still represents the most economical production method, and a small sand core shop is kept busy on this type of work. This shop contains a sand dryer, mixing mill, moulding benches, and $CO_2$ curing equipment.

*A part of the core shop where the shell cores are produced*

In the fettling shop, through which all castings pass, are several "Midsaw" bandsaws of varying capacities, grinders and backstand machines, and a disc linisher. These cope effectively with the removal of runners, gates and flash, and remove burrs or other protrusions from faces required to be flat.

Although the majority of the castings go direct to customers who carry out their own machining requirements, a small machine shop is equipped for drilling, reaming and capstan work to commercial limits.

Inspection features largely in the efforts to reduce scrap and obviate customers' rejects, and a well-equipped inspection department is engaged on the final inspection of castings before they leave the works. Each batch of castings is numbered, and any complaint regarding a casting can at any time be traced back to its particular batch.

A proportion of the castings is called for in the heat-treated condition, and a separate department is maintained to carry out this work. Pressure testing is also a regular operation for certain classes of castings. Adjacent to the foundry is the die maintenance department, where day-to-day repairs are carried out on dies in use in the foundry.

Since such a wide variety of castings is produced, and dies cannot be dispensed with lest a repeat order comes in, the die store occupies a large area.

The die design department, which originates designs for all the company's dies for both the Handsworth and Presteigne works, plays an important part in the firm's progress, and co-operation between this department

*Left: Assembling shell cores into a gravity die for a turbine*

*Right: A part of the aluminium foundry at Presteigne*

and customers is encouraged, especially in the earliest stages of the development of a design. Similarly, the toolroom produces and modifies all pressure and gravity dies, although the nucleus of a toolroom is being built up at Presteigne.

## Pressure Die-Casting Foundry

At Presteigne, the foundries occupy three bays at the rear of the offices and fettling shops. Two of these comprise the aluminium foundry, and the other is the zinc foundry.

In the zinc foundry there are three types of pressure die-casting machines. Six of these machines are Kippcasters, two are E.M.B. No. 12 die-casters, and there are two Schultz machines — a 16½ in. and a 20 in. Metal for the machines is melted in a 300 lb. Berry bale-out crucible furnace, melt temperatures being controlled and recorded by pyrometer recorders.

One of the features of the foundry operation is the employment of the "Centralograph" system for recording continuity of machine operation. Each of the machines is connected to this system, every shot being recorded on a chart in the office with a record of the time interval. Thus, the duration of any waiting time, stoppage or breakdown is shown on the chart, and each day the chart is analysed and compared with shop reports. Also at each machine is a dial of telephone type, by means of which the operator can record a number on the "Centralograph" chart to indicate the reason for a given stoppage; thus, dialling three may indicate an electrical breakdown, while five may signify a die change.

One of the advantages of this system, apart from the immediate one of indicating operating rate, is that the charts can be analysed over a period, and if a particular reason for stoppage appears to be recurrent, steps can be taken to deal with the origin of the trouble.

In the larger machines it is often necessary to use power-assisted (hydraulic) core pullers, since many of the castings in production require complex coring. This creates problems with the guarding of the machines, and screens have been intro-

(*continued on page* 510)

*Kippcasters, and at the rear E.M.B. machines in the zinc pressure die-casting foundry at Presteigne*

HEAT-TREATMENT OF ALUMINIUM-MANGANESE ALLOY CIRCLES BEFORE DRAWING

# Flash Annealing

AT their Dolgarrog Works in North Wales, The Aluminium Corporation Ltd., are operating a new type continuous flash annealing furnace in which circles of aluminium-manganese alloy are heated rapidly by radiation, to produce the fine grain structure needed for deep drawing. Results comparable with salt bath treatment are being achieved with freedom from distortion, staining and surface damage.

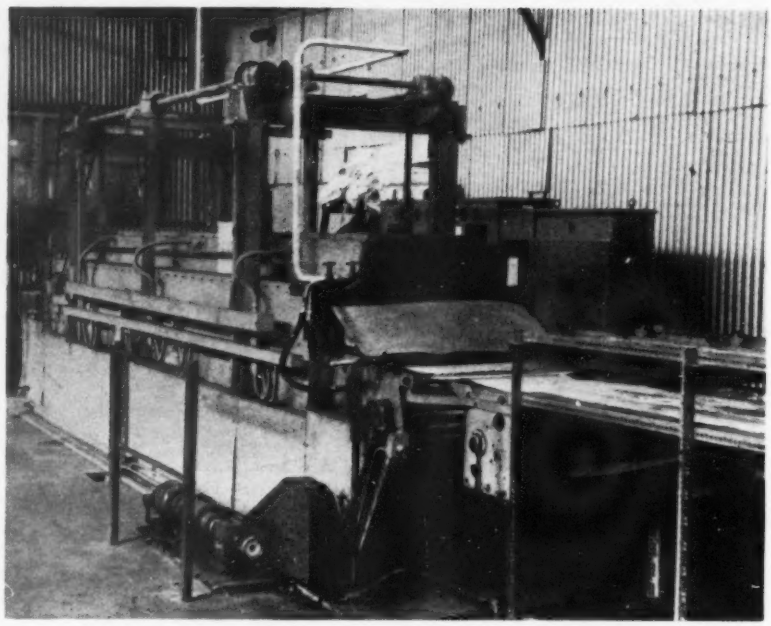
The radiant flash annealing furnace was designed and manufactured by Royce Electric Furnaces Ltd., Sir Richard's Bridge, Walton-on-Thames, Surrey, in conjunction with the Aluminium Corporation. The radiation is obtained from heating panels, which are fitted with heavy gauge nickel-chrome heating elements and positioned in the roof and the hearth of the furnace.

Variations in heating rates are readily made by adjusting the spacing of the panels from the work, the roof and hearth being built as separate units suspended from the main framework of the furnace and contrabalanced. These units are moved by synchronously driven jacks operated by hand wheels which allow fine adjustments to be made. The furnace can be opened in this way to give easy access to the interior and the heating elements. A gauge is provided to show the spacing of the heating panels from the charge.

The sides of the furnace are supported on a floor standing framework and are enclosed in a sheet metal casing. Vertical sliding doors at both ends of the furnace allow the entrance and exit to the heating chamber to be closed as far as possible to reduce heat losses.

The charge is carried through the furnace on a horizontal conveyor, which has two endless chains running along the sides of the chamber and carrying cross flights of heat resisting steel. The cross flights are covered with woven asbestos cloth to provide a non-abrasive support. The conveyor is driven by a squirrel cage motor through reduction gear. Its speed can be varied between 4 and 30 ft/min.

In the design and control of the Royce flash annealing furnace, special precautions are taken to avoid temperature fluctuations. The elements are supported in grooved refractories of high density which, having a high heat content, serve as a heat reservoir. The temperature of the furnace is controlled in four independent zones, the automatic indicating controllers being used not to switch the element supply but to regulate the supply voltage. The conveyor temperature is maintained as far as possible when it leaves the heating chamber by providing a closed and heat insulated return path.



*Flash annealing furnace heated by radiant panels, and built by Royce Electric Furnaces Ltd. in conjunction with The Aluminium Corporation Ltd.*

Safety precautions are incorporated in the furnace to protect the elements from damage by overheating, and to protect a charge should the conveyor be stopped accidentally. In this event the supply to the elements is removed automatically and an alarm is sounded.

The furnace has a rating of 90 kW, it provides temperatures up to 900°C., and has a heating chamber 21 in. wide by 15 ft. long. Heating times for circles ranging from 6 in. to 20 in in diameter, and from 0·020 in. to 0·080 in. thick, vary from 1½ to 4 min. The output of circles of 18 gauge material, 12 in. in diameter, is a little over 2 cwt/hr.

## Tailor-Made Alloys (*continued from page* 504)

of limited applicability that this kind of prediction is possible. A fine example is the work of Keeneford at A.R.D.E. on the development of an alloy steel resistant to thermal stress cracking and softening after tempering at temperatures up to approximately 600°C. He first systematically investigated the effect of individual alloying elements on transformation volume changes and on the breakdown of martensite during tempering and, from these experimental results he was able to conclude that a steel containing 2 per cent silicon and 0·75 per cent molybdenum would have the desired properties. A study of an alloy of this composition confirmed the predictions.

From our limited survey it can be concluded that the present understanding of metals and alloys is not sufficiently advanced for alloy development to be carried out theoretically (research laboratories are still necessary) and the main value of our new knowledge is in guiding experimental work along the right lines. What is needed in the future, and to a certain extent has perhaps been lacking in the past, is a closer link between the metal physicist and the practical metallurgist so that, as far as possible, the metallurgist is fully aware of theoretical developments and, in turn, the metal physicist should attempt to apply his knowledge to the complex problems associated with commercial materials.

### References


1 National Physical Laboratory Symposium, "Creep and Fracture of Metals at High Temperatures," 1956, p. 147.

2 J. Glen; *J. Iron and Steel Inst.*, 1958, **190**, 114.

3 W. Hume-Rothery; *Proc. Roy Soc.*, 1951, **208A**, 431.

**Pressure Die-Casting Review**

# Die-Casting Production in 1958

By L. J. BRICE, M.Sc., F.I.M.

DIE-CASTING in aluminium, magnesium, copper and zinc alloys has become a well-established and important process for the economic production of suitably designed shapes in relatively large quantities and to reasonably accurate dimensions. An attempt has been made to obtain a survey of the activities of the die-casting industry during 1958, and the results are summarized herewith under the various alloy groups.

## Aluminium Alloys

Compared with 1957, there was a rise of over 5·7 per cent in the tonnage of gravity die-castings and over 9·3 per cent in that of pressure die-castings despatched. In the same years, die-castings accounted for 73·3 per cent and 76·5 per cent respectively of all aluminium alloy castings produced. The actual U.K. figures, based on Ministry of Supply returns, are given in Table I.

These figures should probably be increased by a small amount to allow for the output of firms who do not report to the Ministry of Supply.

Generally speaking, the alloys used were those specified in B.S.1490, which covers nineteen compositions for gravity die-castings and five for pressure die-castings. No separate figures are available for production in each of these alloys, but among the compositions most commonly used as-cast or heat-treated were:—

(a) *For gravity die-castings*: LM.4 (probably the most popular), LM.6, 8 and 10; LM.22 for higher strength; LM.13 and 14 for operation at elevated temperatures.

(b) *For pressure die-castings*: LM.2 and LM.24; LM.6 and LM.20 for large surface areas and thin walls.

The relative tonnages of castings (sand and die combined) produced for various groups of end uses are kept confidential to the industry. It is generally known, however, that the various forms of transport absorbed the largest tonnage of aluminium alloy castings; other important outlets being in the spheres of domestic and office equipment, and electrical plant and equipment. The relative proportions of sand- and die-castings absorbed by these end uses are not known.

The trend from sand casting to gravity die-casting, and from gravity to pressure die-casting continued. The development of larger pressure casting machines made possible an increase in the size of pressure die-castings produced. Safety measures were also improved.

## Magnesium Alloys

Again comparing "total despatched" for 1957 and 1958, gravity die-castings fell by 6 per cent, pressure die-castings by 10 per cent, and taking into account sand castings, there was an overall production drop of nearly 28 per cent. Die-castings accounted for only 12 per cent of total production of castings. The U.K. figures, based on Ministry of Supply returns, are given in Table II.

The die-casting alloys used were covered by the following:

(a) *For gravity die-castings*: B.S. 1273, 1274, 1275 (AZ 91 as-cast, solution treated and fully heat-treated respectively), D.T.D.721 (Z 5Z heat-treated), D.T.D.708 (ZRE1 as-cast and annealed), and "C" alloy (aluminium 7·5-9·5 per cent, zinc 0·3-1·5 per cent, manganese 0·15 per cent minimum).

(b) *For pressure die-castings*: B.S. 1273 (AZ 91) and A8X (aluminium 8 per cent + beryllium 0·5 per cent).

The tonnages of each alloy produced are not known. The "C" alloy was, however, the most widely used of gravity die-cast alloys; it was also used successfully for pressure die-castings.

No figures are available for production of die-castings for the various groups of end uses, but among applications of importance were: road transport, textile and agricultural machinery, building and constructional equipment, office machinery, small tools, optical, electrical and radio equipment, vacuum cleaner parts, airframes, printing, lightweight saws.

Although a certain amount of ground appears to have been lost in 1958, there are indications that renewed interest by motor manufacturers in the use of magnesium alloy die-castings may lead to some recovery in 1959.

## Zinc Alloys

The copper-free alloy to B.S.1004A continued to hold the field almost exclusively, although a relatively small amount of the copper-containing alloy to B.S.1004B was used for certain manufactures, such as zipp fasteners.

The consumption of the alloys for 1958 was of the order of 49,000 tons, this being approximately 7 per cent higher than the figure for 1957.

The motor industry accounted for approximately 60 per cent of the total consumption in 1958; other important end uses were home appliances and toys (10-14 per cent each), hardware (5 per cent), machinery, tools, scientific, commercial and office equipment (10 per cent).

## Copper Alloys

Unlike the position with regard to groups mentioned previously, there is no central organization which can provide detailed information concerning overall production figures for copper alloy die-castings. It was thus necessary to communicate directly with firms known to produce copper alloy

TABLE I—ALUMINIUM ALLOY CASTINGS

| | 1957 (Tons) | | 1958 (Tons) | |
|---|---|---|---|---|
| Sand Castings | 21,023 | (26·7 per cent) | 19,046 | (23·5 per cent) |
| Gravity Die-Castings | 42,032 | (53·0 per cent) | 44,446 | (54·8 per cent) |
| Pressure Die-Castings | 16,096 | (20·3 per cent) | 17,607 | (21·7 per cent) |
| Total Die-Castings | 58,128 | | 62,053 | |

TABLE II—PRODUCTION OF MAGNESIUM ALLOY CASTINGS

| | 1957 (Tons) | | 1958 (Tons) | |
|---|---|---|---|---|
| Sand Castings | 2292·1 | (91 per cent) | 1610·2 | (88 per cent) |
| Gravity Die-Castings | 157·2 | (6 per cent) | 147·5 | (8 per cent) |
| Pressure Die-Castings | 76·7 | (3 per cent) | 68·7 | (4 per cent) |
| Total Die-Castings | 233·9 | | 216·2 | |

**TABLE III—DIE-CASTINGS IN COPPER ALLOYS**

| Alloys | Gravity Die-Castings (Tons) | Pressure Die-Castings (Tons) |
|---|---|---|
| "60/40" Brass and Naval Brass | 526·5 | 812·5 |
| | These returns cover "60/40" brass, B.S. 1400-B4-C, B.S. 1400-B5-C (Naval Brass) and composition to B.S. 218 | |
| Aluminium Bronze and High Tensile Brass | 1587 | 400 |
| | The alloys quoted in the returns include:—B.S.1400-AB1-C, B.S.1400-AB2-C, B.S.1400-HTB1-C, D.T.D.174A and 412, "90/10" Aluminium Bronze. The alloys principally used were to B.S.1400-AB1-C and AB2-C. | |
| Silicon Brass | — | 86 |
| | No remarks | |
| Unspecified | 506 | — |
| | This group covers generally brass, aluminium bronze and high tensile brass, tonnages for individual alloys not having been given. | |
| TOTALS | 2619·5 | 1298·5 |

die-castings, and Table III is a collation of the information submitted in reply to a questionnaire. The co-operation of these firms, enabling what is believed to be a reasonably accurate estimate of production to be obtained, is very much appreciated. The figures quoted in Table III are thought to cover most, if not the whole, of the production in the country.

The end uses were very varied, covering motor, transport, electrical, general engineering; electronics; food plant; hospital instruments; plumbing and sanitary fittings. Steady or increasing demand over the year was reported by several firms, and at least one firm developed techniques for casting to closer dimensional limits and to improved surface finish. In one case a tendency to replace sand by gravity die-castings was noted; in another, gravity die-castings were being replaced by shell moulding. The use of Superston 40 was mentioned.

Acknowledgment is made to the Zinc Alloy Die Casters Association for the information relative to zinc alloys, to the Aluminium Industry Council and to Mr. A. P. Fenn (Birmingham Aluminium Casting Co. Ltd.) for help in the preparation of the data on aluminium alloys, and to the Magnesium Industry Council and Magnesium Elektron Ltd. for their assistance in the preparation of details relating to magnesium alloys.

# Die-Caster's Jubilee (*continued from page* 507)

duced between adjacent machines, so that the dangers from splash are minimized.

After castings are removed from the machines they are placed into transportable bins for removal to the fettling shop. This shop is on an upper floor and here all runners and flash are removed. Although hand fettling is still used to some extent, a "Midsaw" bandsaw is used for the heavier work and linishers and backstand machines are in use. Tumbling is also being increasingly used, and presses using multiple tools deal with clipping and blanking operations.

The aluminium foundry, occupying the two bays adjacent to the zinc foundry, has five Reed-Prentice 1½ G. machines, three E.M.B. No. 12 machines, and an E.M.B. No. 14. The Reed-Prentice machines are semi-automatic, providing a variable cycling time from 6 to 90 sec. The E.M.B. No. 12 machines are adapted for cold chamber operation and are manually controlled, but the E.M.B. No. 14 is semi-automatic. In this foundry, runners and sprues are broken from the castings as they are removed from the dies, and the castings then go to the fettling shop for flash removal. (Aluminium castings are handled in a separate fettling shop from that in which the zinc castings are trimmed.) The fettling shop for aluminium castings is adjacent to the aluminium foundry, and fettling shop scrap is returned direct to the foundry for remelting. In addition to a "Midsaw" bandsaw, there are a belt linisher and a backstand machine for trimming castings.

Next to the fettling shop is a small machine shop equipped with Southwark No. 2 capstans, where any machining that may be required is carried out. In general, the demand for machining is not great, since the foundries are essentially jobbing foundries, and castings vary from ¼ oz. in aluminium to approximately 3 lb., and up to 8 lb. in zinc.

Other departments at the Presteigne works include the toolroom, inspection and despatch departments. The toolroom is, for the most part, occupied with the maintenance requirements of the production departments, but some new dies are being made. New equipment is being installed and efforts to increase the staff of skilled men by the training of apprentices are being made.

One feature of special interest at the Presteigne works is the liquid fuel installation—believed to be the first of its kind in this trade in the U.K. This consists of two 10-ton storage tanks containing propane, which is metered off at 5 lb/in² to supply gas heating for the furnaces and machines. The supply from the tanks is controlled by a diaphragm valve, consumption of the liquid fuel being approximately 4 tons/week. In the event of very cold weather interfering with vaporization of the liquid fuel, a special unit which passes the fuel through a water-heated jacket is installed.

This plant has been installed only recently, replacing a producer gas installation which, though it had supplied the furnaces for some years, was not so reliable nor so consistent as the present unit.

## New Laboratory

The most recent development in the company's progress is the establishment of a works laboratory at Handsworth. This is primarily intended to undertake the solution of foundry problems should queries arise, and to deal with quality control to A.I.D. requirements and other specifications. The nature of the company's products demand only limited analytical control, but within those limits the laboratory has been equipped to meet all the demands likely to be made upon it.

Compactness has been the keynote of the laboratory layout, and wet analysis benches, fume cupboard, storage cupboards and drawers are readily accessible. A separate room houses a Spekker absorptiometer and balance, thus providing further facilities where wet analysis methods are insufficient. Outside the laboratory proper, a small muffle is provided for such heat-treatment as may arise.

Freedom from fumes is an essential prerequisite for comfortable conditions and freedom from corrosive attack, and in this small laboratory, where fume extraction is of paramount importance, a Vent-Axia fan is fitted in the fume cupboard, ensuring a thoroughly clean atmosphere elsewhere.

# Industrial News *Home and Overseas*

### Continental Orders

Despite severe competition, **Wild-Barfield Electric Furnaces Limited** have obtained a number of orders from France and Belgium, among the more interesting being a complete heat-treatment installation for the hardening, steam tempering etc., of a variety of watch parts. This order was received from Usines Kelton of Besançon for the manufacture of watches and clocks under licence from Timex Ltd., and calls for equipment similar to that installed in the Dundee factory of the latter. For hardening purposes on a continuous basis, a small shaker hearth furnace is being manufactured having a tray width of 2 in. This small compact production unit has proved extremely popular for a wide range of diverse components where the accent is on numbers as opposed to weight output and it has rightly found a place for itself in many factories engaged in the production of tiny repetition parts in large quantities. It will be complete with automatic temperature control, and protective atmosphere will be supplied by a G.W.B. endogenerator, the resultant gas being enriched by the addition of propane. Steam tempering will be carried out in a forced convection furnace in which the steam is vigorously circulated in the same positive manner as in the well-known range of Wild-Barfield tempering furnaces. Other furnaces include a special retorted pit type unit and a small electrode salt bath with metal pot for operation up to 960°C.

The low pressure die-casting system developed by Alumask Ltd., of Burton Latimer is to be employed under agreement by Société de Fonderie d' Aluminium et d' Alliages Legers of Arandon (Isère), and Wild-Barfield are supplying a mains frequency induction heated aluminium holding furnace for the process having some 750 lb. capacity. The equipment, rated at 40 kW, will have a nominal charge space of 24 in. inside diameter with a depth of 30 in.

A further gas carburizing equipment of the vertical pit type has been ordered by Fabrications Automobile Belges of Antwerp through the Belgian Company of Wild-Barfield, bringing the total now to four. In addition to the vertical pit type furnace, a "Carbodrip"/ammonia control panel will be supplied to enable the installation to be employed either for gas carburizing or carbonitriding and suitable jigs for the components to be treated have been designed.

### European Agents' Conference

A conference was held recently at the Chateau Impney, Droitwich, by **High Duty Alloys Limited** for their European agents. This was the first conference of its kind and due to its success, both from a technical and social aspect, the company has decided that this should become an annual event. Papers were read by the company's technicians on forgings, extrusions, castings and sheet, and these were interspersed with refresher tours of the forgings division at Redditch.

Our photograph on this page shows some of the hosts and guests at this conference. From left to right they are: Mr. E. T. Stewart-Jones (development engineer, forging division); Mr. Paul P. Beck (Denmark); Mr. P. E. Lagerhjelm (Switzerland); Mr. Boonstoppel (Western Germany); Mr. H. J. Proffitt (development engineer, casting division); Mr. E. W. Peel (forging division manager); Mr. J. E. Fearon (Metallurgist, extrusion division); Mr. Paul Alexis (Belgium); Mr. B. W. Walker (Assistant export manager); Mr. P. R. Bourgeois (France); Mr. R. T. Thorley (metallurgist, rolling division) and Mr. John Fisher (export manager).

### Canadian Copper and Nickel

Production was smaller for copper but larger for nickel in April this year than last, while output of both metals was smaller in January-April than a year ago, the Dominion Bureau of Statistics reports. April copper output fell to 32,028 tons from 32,635 in the same month of 1958, while nickel edged up to 15,493 tons from 15,163. January-April copper production dropped to 117,140 tons from 130,410 in the first four months of last year and nickel to 51,078 tons from 63,622.

### Bronze and Brass Founders

Members of the **Association of Bronze and Brass Founders** in the Lancashire and Cheshire areas are holding a meeting on Tuesday, June 30, at the Engineer's Club, Manchester, commencing at 5 p.m. with tea. After dealing with current matters Mr. G. H. Charsley will give a talk on recruitment and training in the foundry industry.

### West German Exports

Exports of semi-manufactured copper and copper alloy goods to East European countries were mainly responsible for higher non-ferrous metal exports by West Germany in 1958. This was stated in the annual report of the West German Non-Ferrous Metal Institution issued recently. Exports of non-ferrous metal semi-manufactured goods last year rose by 21·6 per cent, the report said. Those of copper or copper alloys were 28 per cent higher and those of aluminium or aluminium alloys 13 per cent. Raw non-ferrous metal exports last year amounted to 144,500 tons, a rise of nearly 20,000 over 1957. Exports of copper rose by 30 per cent and those of zinc also increased.

Consumption of non-ferrous metals in West Germany advanced last year by five per cent over 1957, the report said. Lead output last year at 60,914 tons—in terms of recoverable lead—was 14·3 per cent below that of 1957, and zinc output at 85,400 tons 9·4 per cent below that of 1957. The report attributed this to the fall in world lead and zinc prices which cut West German mines' income by an average of 40 per cent, and caused nine mines to close down.

Imports of non-ferrous metals increased during the year. West German production of non-ferrous metal semi-manufactured goods rose 5 per cent last year to 785,000 tons, the report said.

### Copper Refining in Canada

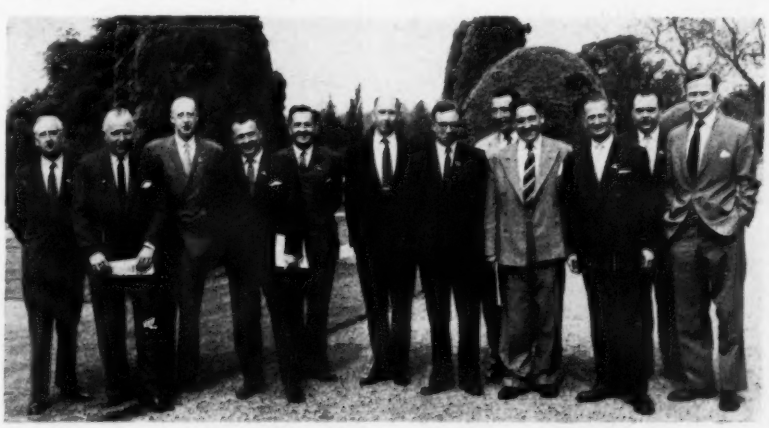
Recent news from Quebec is that Premier Duplessis has announced that construction of a refinery in the Chibougamau district has been approved in principle by a number of companies mining copper in the area. The announcement was made during a brief Press conference following the swearing-in of Mr. Raymond Douville of Trois-Rivieres as Under-Secretary of the Province.

The Premier said the project had just been approved in principle and that no concrete plans had been made. Site would be either at Chibougamau or Chapais; both communities are about 310 miles north of Montreal and are about 30 miles apart. The refinery would permit exploitation of low-grade ores which are too expensive to transport in their raw state. Among the companies which had expressed interest in the project, Mr. Duplessis said, were Opemiska Copper Mines (Quebec) Ltd., Copper Rand Chibougamau Mines Ltd. and Campbell Chibougamau Mines Ltd.

### Australian Lead and Zinc

Broken Hill union leaders last week appealed to the Federal Government Mining Committee to encourage the

*High Duty Alloys Ltd. European agents' conference*



Government to purchase and stockpile Australian-produced lead and zinc until world prices became stabilized. This would be the main solution toward combating the present recession in Broken Hill, according to Mr. W. S. O'Neill, President of the Barrier Industrial Council.

Union leaders met the Committee at an informal conference. The Committee is on a tour of mining centres in Australia. Other proposals suggested by the local delegates were: (1) A Government subsidy to mining companies instead of paying unemployment relief to miners; (2) exploring and developing known deposits of new metals, such as beryllium, in the Broken Hill district, and (3) developing metal markets in the Far East.

### Trade with Denmark

There has recently been a list of goods, published by the Danish Ministry of Commerce, for which import licences are required before entering Denmark. Included in this list are the following:—**copper,** semi-fabricated and fabricated articles; **nickel** in wrought bars, rods, angles, shapes, etc.; **aluminium** in rods, angles, shapes and sections, plates, sheets and strips, semi-fabricated and fabricated; **magnesium** and **beryllium** in bars, angles, shapes, foil, shavings, powdered, etc.; **lead** in unwrought, scrap, wrought bars, rods, shapes and sections, plates, sheets, foil, etc.; **zinc** in various forms; **tin** in unwrought and wrought form, and other base metals employed in metallurgy and articles thereof, such as tungsten, molybdenum and tantalum.

### Thailand Import Tariffs

It has been announced by the Government of Thailand that with effect from June 6 last, import tariffs on all goods, except gold, have been increased by 10 per cent.

### Bauxite in Belgian Congo

It is reported from Brussels that a bauxite deposit estimated at some 50 million tons has been found in the lower Congo near the prospective site for the hydroelectric power station at Inga. They added that this estimate, confirmed by the prospecting firm Bamoko, was on the conservative side and deposits might even total 100 million tons. The quality of the bauxite was reported to be average, and its iron content fairly high.

### Keetona Shears

A new range of ½ in. capacity shears is now available from **Keeton, Sons and Co. Ltd.,** a member of the Firth Cleveland Group. The first model, the Keetona 8 ft. by ¼ in. shears illustrates the features of the new models.

For the first time Keetona shears are supplied in fabricated steel construction, and other new features include instantaneous clutch engagement, toggle action mechanical hold down (or, alternatively, hydraulically operated hold down), easily accessible blades for changing and efficient one-point lubrication. Modern box-type construction minimises deflection, ensures rigidity, smooth operation and a high degree of accurate shearing to the maximum capacity of the machine.

The action of the cutting beam is inclined at 2° to the vertical. Using square four-edge blades, it presents the corner of the upper blade to the material, giving the same effect as with two-edge bevelled blades. The lower blade is fastened square to the table and is flush with the top. The cutting blades can be straight sided. There is no risk of the sheared material trapping between the lower blade and the back gauge, as the latter moves away from the lower blade whilst cutting. The hand operated micrometer back gauge is fitted to the shear as standard equipment at no extra cost.

### European Pressure Die-Casting

Of almost every conceivable shape and size, pressure die-castings from the major countries of Europe have been on show this week at the Birmingham Engineering Centre. The exhibition, organized by the **Zinc Alloy Die Casters' Association** in conjunction with the **Light Metal Founders Association,** shows to advantage how wide is the range of products in which pressure die-castings are used.

Zinc and aluminium alloys figure predominantly in this exhibition and one of the largest, though not the heaviest, is a top cover for an electric computer in aluminium alloy, 32 in. long by 14 in. wide by 10 in. deep. At the other end of the scale are radiator motifs, nameplates and the like. A number of components cast in magnesium alloy are also on show. Among the countries represented at this exhibition are, in addition to Great Britain, Belgium, Denmark, France, Germany, Sweden, Switzerland, and Holland.

### International Meeting at Copenhagen

Delegates from the copper and copper alloy fabricating industries of thirteen Western European countries were present when the General Assembly of the **International Wrought Non-Ferrous Metals Council** met in Copenhagen on June 15, under the chairmanship of Mr. C. A. Jacobsson, of Sweden.

Mr. Jacobsson will be retiring from the chairmanship of the International Council in October, and the General Assembly unanimously elected Mr. W. Ertel, of Germany, as his successor. The Hon. J. Grimston, M.P., of Great Britain, has been unanimously elected a vice-chairman. The other vice-chairman of the International Council is Dr. A. De Meuron, of Switzerland.

Most members reported that production of copper and copper alloy semi-finished products in the first quarter of this year has been below the monthly average for 1958. There is evidence to show that the European fabricating industry is slowly emerging from a period of recession, and there is confidence that business will show an improvement during the second half of this year.

The meeting reviewed the activities of the International Council during the past year, the sixth since its foundation in October 1953. The Development and Technical Committees have continued their work. The Technical Committee has had a considerable measure of success in organizing productivity surveys for a number of products which have been of undoubted benefit to members. It is to be hoped that these surveys will result in an improved standard of productivity in the European industry. The Technical Committee compiles annual accident reports and statistics which receive a wide circulation. This information is of great value in enabling individual companies to assess their own accident loss ratios.

The Development Committee has been pleased to note the emergence of substantial co-operation between the development organizations in the various European countries. Nothing but good can come from such co-operation, which, it is hoped, will result in increased demand for the Council's products.

The General Assembly proposes to hold its next meeting in Switzerland in June 1960.

### U.K. Metal Stocks

Stocks of refined tin in London Metal Exchange warehouses at the end of last week rose 20 to 7,796 tons, comprising London 4,779, Liverpool 2,353, and Hull 664 tons. Copper stocks rose 546 to 13,858 tons, and comprised London 2,696, Liverpool 5,812, Birmingham 1,175, Manchester 4,050 tons and Hull 125 tons.

### Nigerian Tin

Nigeria is to export 1,525 tons of tin during the third quarter of this year, it was officially announced. This figure, representing an increase of 168 tons or 0·2 per cent over this quarter's allocation of 1,357 tons (5·9 per cent) and 345 tons over the first quarter's allocation of 1,180 tons, was approved by the International Tin Council, of which the Federation of Nigeria is a member, at its last meeting, held in Copenhagen last May.

Production of tin ore in April 1959 is officially reported as 557 tons, compared with 518 tons in March. Columbite output was 114 tons, compared with 88.

### Aluminium in Japan

It is reported by the Japan Light Metals Association that both the output and deliveries of primary aluminium in April hit postwar highs, reflecting brisk demand for the products. Stocks of primary aluminium at the end of April notably decreased compared with those at the end of March. No export shipment was made during April owing to the brisk demand in the domestic markets.

# Scrap Metal Merchants' Association

ON Wednesday of last week (June 10) the annual meeting of the **National Association of Non-Ferrous Scrap Metal Merchants** was held at Grosvenor House, London, S.W., under the chairmanship of the retiring President, **Mr. R. O. Barnett.**

Following his report given to the members at the December half-yearly meeting, the President's report on this occasion covered the activities of the association during 1959 to date.

In the course of his report the President said that the Council had held the usual six meetings in the first half of this year, all of them being in London. The present membership of the association was 305. Reference was made to the successful course of lectures on the technical aspects of the non-ferrous scrap metal industry held at the College of Technology, Birmingham.

Since the December half-yearly meeting the report of the inquiry into the methods adopted by the London Electricity Board for the disposal of scrap cable, together with the correspondence relating thereto between the Minister and the Chairman of the Board had been published. It was apparent that although certain improvements were recommended, the Board would not be changing its methods of disposal in view of the recommendations in the report. The

Council of the association was of the opinion that after many years of active negotiation, it would not be in the best interests of the association at the present time to pursue further negotiations to bring about a change of procedure.

Full details relating to the activities of the Joint Non-Ferrous Scrap Committee were given in the report including the efforts made to influence the Government to liberalize the export of all non-ferrous scrap, wastes and residues.

A very cordial meeting had taken place recently between members of the Council and representatives of the Association of Light Alloy Refiners and Smelters. The main outcome of this meeting was that it was agreed that the specifications on which the smelters were buying scrap were too wide. The existing specifications require tightening up so that merchants who graded material obtained the correct price. The Refiners and Smelters agreed to draw up revised specifications where appropriate for consideration by the scrap metal merchants association and these are being awaited. Another point which arose from this meeting was that there was no definite agreement for price fixation within the Smelters' Association.

The President referred with regret to the fact that neither Mr. Leopold Lazarus nor Mr. P. O. Jones found it possible to seek re-election to the Council this year and he expressed his personal thanks to both for the valuable assistance they had given to the Council and association.

Following the President's report the Financial Statement for the year ended December 31, 1959, was presented and approved.

**Mr. J. K. Lion**

Mr. Barnett then proceeded to install **Mr. J. K. Lion** as President of the Association for the ensuing year. It was also announced that **Mr. D. J. R. Austin, Mr. R. O. Barnett, Mr. Victor Brenner,** and **Mr. S. Sternberg** had been re-elected as members of the Council. **Mr. H. G. Shields** was elected as vice-president, and **Mr. A. C. Wood** was re-elected as honorary treasurer.

Following the annual general meeting the annual luncheon was held presided over by **Mr. J. K. Lion,** President of the Association. Among the distinguished guests at the top table were the **Hon. John Grimston,** M.P. (President of the British Non-Ferrous Metals Federation), **Mr. R. Gresham Cooke,** C.B.E., M.P.; **Dr. I. G. Slater,** M.Sc., Ph.D., C.I.Mech.E. (College of Technology, Birmingham); **Mr. K. Romer Lee** (Director of the British Non-Ferrous Metals Federation); **Mr. F. R. Rust** (Director of Disposals, Ministry of Supply); **Mr. L. J. Banford** (Director of Contracts, Air Ministry); **Mr. B. Pool** (Director of Navy Contracts); **Mr. E. L. Palmer** (Export Licensing Branch, Board of Trade); **Mr. R. Hahn** (President, Association of Light Alloy Refiners and Smelters); **Mr. J. D. Wolff** (chairman, the London Metal Exchange); **Mr. W. R. Buxton** (vice-president, Association of Bronze and Brass Founders) and other personalities from the industry.

After the Loyal toast had been proposed by the President, the toast of "The Association" was proposed by the **Hon. John Grimston,** M.P., who, in the course of his remarks made reference to the question of scrap metal exports and said that from the point of view of the metal fabricators the liberalization of scrap metal could not be supported so long as no other countries were willing to allow it as well.

In his response to this toast, the President, **Mr. Lion,** said that he did not accept the argument that liberalization of scrap exports, without parallel measures by other countries, would mean that all scrap would disappear from this country. He added that it was illogical that exports should be allowed of refined metal but not of scrap. Mr. Lion also said that a scrap merchants' deputation, sent to the Board of Trade to urge the freeing of U.K. scrap exports, was told that an O.E.E.C. working party was to be set up to co-ordinate member countries' scrap export policies.

The toast of "Our Guests" was proposed by **Mr. R. O. Barnett** (Immediate Past-President of the Association) and response was made by **Mr. R. Gresham Cooke,** C.B.E., M.P.

# Industrial Safety Equipment

SPONSORED by the **Birmingham and District Industrial Safety Group,** an exhibition was opened today at the Bingley Hall, Birmingham and will remain open until Friday of next week June 26. The exhibition is designed, as in previous years, to stress the importance to all industries of providing the ever increasing range of safety equipment available to industry today.

There is no doubt that each year sees an increasing number of firms taking a serious interest in the necessity for measures to prevent industrial accidents of all kinds and in the exhibition now presented at this Birmingham hall many devices which provide for the safety of workers in all types of factories and workshops may be seen.

Included in the engineering section of the exhibition are stands devoted to exhibits by group members of a non-commercial nature. These are ideas which have been tried and proved successful in their organizations and are exhibited to allow visitors to adopt them in their own works if they so wish.

In the building section, a stand occupied by John Laing and Son Ltd., is demonstrating how that company communicates safety to its employees. Registered apprentices with the Midland Federation of Building Trades' Employees demonstrate their skill and there are also junior and senior sections in building, plumbing and carpentry. All these demonstrations should attract a great deal of interest on the part of the visitor.

Although this very important subject—efficiency with safety—is now largely recognized as being a matter of importance to managements and that considerably more attention is being paid to these matters than in previous years, it is surprising that there are still manufacturing concerns which regard this problem as one which they can look upon as of only secondary importance. The facts which are annually presented in H.M. Factory Inspector's reports show that in spite of all the efforts being carried out by such methods as safety campaigns, various types of publicity including exhibitions in a number of industrial areas, the loss to industry caused by accidents and injuries in the factory still mounts to an exceedingly high figure in man-days each year.

The value of this present exhibition to industry cannot be set too high and not only managements, but workers also should make a point of visiting Bingley Hall and seeing for themselves not only the types of equipment now available to provide safety in the works but also to learn of some of the ways in which accidents do so often occur and which could easily have been prevented by the installation of equipment or the provision of suitable clothing.

Among the exhibitors at this exhibition are the following:—

Briggs Industrial Footwear Ltd.
Broughton and Son (Engineers) Ltd., J.
British Visqueen Ltd.
Betts and Broughton Ltd.
British Hoist and Crane Co. Ltd.
British Oxygen Gases Ltd.
Cape Building Products Ltd.
Continental Automatic Machine Co. Ltd.
Alexander Duckham and Co. Ltd.
Expanded Metal Co. Ltd.
J. and R. Fleming Ltd.
Franco-British Electric Co. Ltd.
Gough and Company.
Hadley and Company.
Ibex Petroleum Products Ltd.
Kwikform Ltd.
John Laing and Son Ltd.
Lockers (Wireworkers) Ltd.
Light Alloy Construction Ltd.
Minnesota Mining and Manufacturing Co. Ltd.
Mine Safety Appliances Co. Ltd.
Midlands Electricity Board.
West Midlands Gas Board.
Midland Automatic Catering Ltd.
Northide Ltd.
Protective Footwear Service Ltd.
Parmelee (G.B.) Ltd.
Price Machine Guards Ltd.
Pilkington Brothers Ltd.
Rubery Owen and Co. Ltd.
R.F.D. Co. Ltd.
Rozalex Ltd.
Robertson Thain Ltd.
Steelace Ltd.
Scaffolding (G.B.) Ltd.
Siebe Gorman and Co. Ltd.
J. P. Udal Ltd.
U.K. Optical Bausch and Lomb Ltd.
Weyco Sales Ltd.
Walkers (Century Oils) Ltd.
Wilkins and Denton Ltd.
W. C. Youngman Ltd.

The Department of Scientific and Industrial Research is also providing an exhibit and other organizations taking part are the St. John Ambulance Association, and the Royal Society for the Prevention of Accidents.

# Metal Market News

TRADING on the Metal Exchange last week was restricted and values were inclined to ease, copper being particularly vulnerable to absence of demand. Turnovers, too, were below average, and all in all things were not very exciting. Nevertheless, the reports of the country's trade are encouraging and the outlook is for a further improvement during the ensuing months. Values of non-ferrous metals are not unduly high, and should encourage demand without much fear of a serious recession. Strike fears, which have served to keep the copper market firm for some months, did not appear last week to be exercising quite so much influence, and values closed appreciably lower on balance. The rising trend in L.M.E. warehouse stocks continues, and at the beginning of last week an increase of 414 tons to 13,312 tons was announced. In spite of this, the backwardation continues, but it narrowed somewhat from 25s. to 20s. on Friday last. That it should persist at all with stocks where they are and showing an inclination to mount still higher is surprising, and a matter of much dissatisfaction to all those who use the market for hedging purposes. It has been stated so often that without adequate stocks the copper futures market cannot function properly that one cannot help wondering what is to be regarded as an adequate tonnage. It is certainly true that a contango has been seen in copper with stocks lower than they are to-day. However, with the L.M.E. reserves continuing to rise, it seems pretty certain the "back" will run off soon.

In standard copper, the turnover was about 10,250 tons, and on Thursday, when news came through that the Chuquicamata wage talks had been settled, the quotation dipped to £232 cash and £231 three months. This was the bottom, for some recovery followed and by Friday afternoon the quotation had recovered to £233 cash and £232 three months. Kerb dealings were reported 5s. higher. During the second half of the week in New York, Comex turned easier and by Thursday the dealers' price for physical copper was reported to have eased to 31½ cents, without attracting much demand. On Friday, the Belgian price was reduced to 32·50 francs. Less is now being heard of the prospects of a strike in the United States at the end of this month, and the fall to around £230 rather suggests a feeling that after all no stoppage may take place. Some publicity has been given to the difficulties facing the cable makers and wire drawers at the present time, the emphasis being on the increase in competition likely to be encountered by manufacturers in these fields. A piece of interesting news about the secondary metal situation is that an O.E.E.C. working party will be set up with the idea of examining and co-ordinating the scrap export arrangements of the various countries who are members of the organization. On balance last week, cash copper lost £3 10s. 0d. and three months £3 5s. 0d.

Tin was quite firm last week, and after a turnover of 865 tons, cash closed 30s. up at £789, while three months put on £2 at £791. The close was below the best, but there is a fair amount of optimism about this metal's prospects at the present time. The Tin Pool holding is believed to have been materially reduced during the past few months. Trade buying is moderately good. Little change was seen in lead, which, after a turnover of 6,825 tons, closed 5s. down for June at £69 5s. 0d., while September improved by 5s. to £71 5s. 0d. Quiet conditions ruled in zinc, for only about 3,550 tons changed hands, the close being £77 15s. 0d. and £77 5s. 0d. for the respective positions. June advanced by 15s. and September by 25s.

### New York

No immediate congressional action is expected on the resolution by Senator James E. Murray to proclaim a national mineral policy for the United States. The senator, who is also chairman of the Senate Interior Committee, has asked that his resolution be allowed to lie on the table in the chamber to allow other senators to join with him in sponsorship. The Murray proposal would direct the Secretary of the Interior to submit to Congress within six months after passage of the resolution a plan to keep the United States mining industry "in a healthy condition at all times."

Within one year after passage, the Interior Secretary must submit his recommendations for legislation to be carried out by the Interior Department to assure the U.S. of a minerals industry "both of the common minerals, and metals and those classified as strategic and critical, having the capacity to operate on a sound economic basis regardless of the price of foreign minerals and metals." The Interior Secretary further would be required to submit every six months, a report advising Congress "of the current economic status of each of the domestic mineral industries of the United States."

Non-ferrous metals on the Commodity Exchange last week were quite active and there were heavy exchanges noted in lead. Lead and zinc were steady. Copper lost most of early gains on profit-taking. In physical copper one custom smelter reported light sales for June at 32 cents. Other smelters sold for July delivery.

One dealer said dealer copper was available a shade below 32 cents in limited quantity but no interest was reported. Producer copper was unchanged. One producer was selling July, others have not opened their books yet. Moderate activity was reported in lead and zinc. Tin was softer, reflecting the decline in London. Consumer interest was quiet. In late trading, tin was quiet and steady, and copper, lead and zinc were unchanged. Informed trade sources said labour negotiations at the Anaconda Chuquicamata mine, in Chile, were near a settlement. The new contract would be for 15 months, beginning on July 1, 1959.

### Birmingham

In the metal trades in Birmingham and Midland towns there is a gradual improvement in the trading position. Although capacity is not yet fully employed, most firms have increased their output, and employment figures are better than they have been for several months. Another indication of expansion is the reduction in stocks of raw materials. The motor trade has been beset by a series of labour disputes over the last six months but, despite this interference with output, car manufacturers are producing more vehicles than ever, and home buyers are finding it takes longer to get delivery of the popular makes. Exports are high, particularly to the North American market.

Although steel output last month declined slightly, the loss is attributed to the Whitsun holiday and does not indicate any setback in the general recovery which is taking place in nearly all departments. Structural steel continues rather a slow market, apparently because only a small number of new factories are being planned. Sheet mills continue fully employed on motor car work. Iron foundries are using more of their capacity. Since the Budget there has been a sharp rise in demand for domestic equipment involving iron castings. There is a lull in the placing of orders for steel used in the coalmining industry.

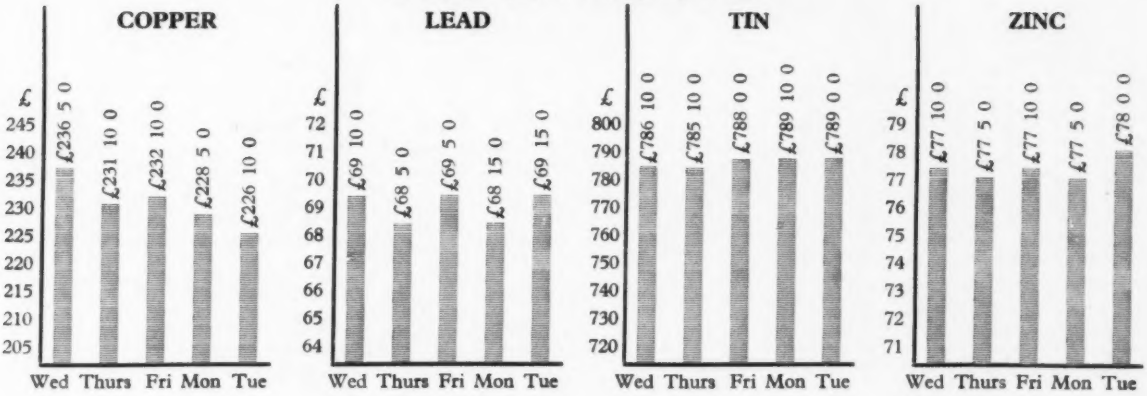
### Paris

News from the non-ferrous market is that activity picked up in zinc, and also in lead, reflecting an improved consumer demand. On the other hand, copper products, particularly alloys, were out of favour and business remained idle. Bronze was again dull. Aluminium consumers find it more and more difficult to secure an adequate tonnage. Sellers were reluctant and asked for high prices, and the market became nominal.

# Non-Ferrous Metal Prices

## London Metal Exchange

Wednesday 10 June to Tuesday 16 June 1959




## Primary Metals

All prices quoted are those available at 2 p.m. 16/6/59

| | | £ | s. | d. |
|---|---|---|---|---|
| **Aluminium** Ingots | ton | 180 | 0 | 0 |
| **Antimony** 99·6% | „ | 197 | 0 | 0 |
| **Antimony** Metal 99% | „ | 190 | 0 | 0 |
| **Antimony** Oxide | „ | 180 | 0 | 0 |
| **Antimony** Sulphide Lump | „ | 190 | 0 | 0 |
| **Antimony** Sulphide Black Powder | „ | 205 | 0 | 0 |
| **Arsenic** | „ | 400 | 0 | 0 |
| **Bismuth** 99·95% | lb. | | 16 | 0 |
| **Cadmium** 99·9% | „ | | 9 | 0 |
| **Calcium** | „ | 2 | 0 | 0 |
| **Cerium** 99% | „ | 16 | 0 | 0 |
| **Chromium** | „ | | 6 | 11 |
| **Cobalt** | „ | | 14 | 0 |
| **Columbite** per unit | | | — | |
| **Copper** H.C. Electro | ton | 226 | 10 | 0 |
| Fire Refined 99·70% | „ | 225 | 0 | 0 |
| Fire Refined 99·50% | „ | 224 | 0 | 0 |

| | | £ | s. | d. |
|---|---|---|---|---|
| **Copper Sulphate** | ton | 76 | 0 | 0 |
| **Germanium** | grm. | | — | |
| **Gold** | oz. | 12 | 9 | 8½ |
| **Indium** | „ | | 10 | 0 |
| **Iridium** | „ | 24 | 0 | 0 |
| **Lanthanum** | grm. | | 15 | 0 |
| **Lead** English | ton | 69 | 15 | 0 |
| **Magnesium** Ingots | lb. | | 2 | 3 |
| Notched Bar | „ | | 2 | 9½ |
| Powder Grade 4 | „ | | 6 | 1 |
| Alloy Ingot, A8 or AZ91 | „ | | 2 | 4 |
| **Manganese Metal** | ton | 245 | 0 | 0 |
| **Mercury** | flask | 77 | 0 | 0 |
| **Molybdenum** | lb. | 1 | 10 | 0 |
| **Nickel** | ton | 600 | 0 | 0 |
| F. Shot | lb. | | 5 | 5 |
| F. Ingot | „ | | 5 | 6 |
| **Osmium** | oz. | | nom. | |
| **Osmiridium** | „ | | nom. | |

| | | £ | s. | d. |
|---|---|---|---|---|
| **Palladium** | oz. | 7 | 5 | 0 |
| **Platinum** | „ | 28 | 10 | 0 |
| **Rhodium** | „ | 41 | 0 | 0 |
| **Ruthenium** | „ | 18 | 0 | 0 |
| **Selenium** | lb. | | nom. | |
| **Silicon** 98% | ton | | nom. | |
| **Silver** Spot Bars | oz. | | 6 | 6½ |
| **Tellurium** | lb. | | 15 | 0 |
| **Tin** | ton | 789 | 0 | 0 |
| ***Zinc** | | | | |
| Electrolytic | ton | | — | |
| Min 99·99% | „ | | — | |
| Virgin Min 98% | „ | 77 | 10 | 0 |
| Dust 95/97% | „ | 109 | 0 | 0 |
| Dust 98/99% | „ | 115 | 0 | 0 |
| Granulated 99+% | „ | 102 | 10 | 0 |
| Granulated 99·99+% | „ | 115 | 17 | 6 |

**Duty and Carriage to customers' works for buyers' account.*

## Foreign Quotations

Latest available quotations for non-ferrous metals with approximate sterling equivalents based on current exchange rates

| | **Belgium** fr/kg ≏£/ton | | **Canada** c/lb ≏£/ton | | **France** fr/kg ≏£/ton | | **Italy** lire/kg ≏£/ton | | **Switzerland** fr/kg ≏£/ton | | **United States** c/lb ≏£/ton | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Aluminium** | | | 22.50 | 185 17 6 | 224 | 165 0 | 375 | 221 5 | 2.50 | 212 10 | 26.80 | 214 10 |
| **Antimony** 99.0 | | | | | 220 | 163 0 | 445 | 262 10 | | | 29.00 | 232 0 |
| **Cadmium** | | | | | 1,350 | 1,012 10 | | | | | 130.00 | 1,040 0 |
| **Copper** | | | | | | | | | | | | |
| Crude | | | | | | | | | | | | |
| Wire bars 99.9 | | | | | | | 455 | 268 10 0 | | | | |
| Electrolytic | 33.25 | 244 15 0 | 30.50 | 252 0 | 332 | 249 0 | | | 3.00 | 255 0 | 31.50 | 252 0 |
| **Lead** | | | 10.25 | 84 12 6 | 103 | 78 0 | 163 | 96 2 6 | .88 | 74 17 6 | 12.00 | 96 0 |
| **Magnesium** | | | | | | | | | | | | |
| **Nickel** | | | 70.00 | 578 5 | 900 | 675 0 | 1,200 | 708 0 | 7.50 | 637 10 | 74.00 | 592 0 |
| **Tin** | 112.25 | 826 7 6 | | | 1,129 | 846 15 | 1,500 | 885 0 | 9.70 | 824 12 6 | 104.75 | 838 0 |
| **Zinc** | | | | | | | | | | | | |
| Prime western | | | 11.25 | 92 17 6 | | | | | | | 11.00 | 88 0 |
| High grade 99.95 | | | 11.85 | 94 0 0 | | | | | | | | |
| High grade 99.99 | | | 12.25 | 101 2 6 | | | | | | | | |
| Thermic | | | | | 115.00 | 86 5 | | | | | | |
| Electrolytic | | | | | 123.00 | 92 5 | 175 | 103 2 6 | 1.02 | 86 17 | 12.25 | 98 0 |

# Non-Ferrous Metal Prices (continued)

## Ingot Metals

All prices quoted are those available at 2 p.m. 16/6/59

| Aluminium Alloy (Virgin) | £ | s. | d. |
|---|---|---|---|
| B.S. 1490 L.M.5 .... ton | 210 | 0 | 0 |
| B.S. 1490 L.M.6 .... „ | 202 | 0 | 0 |
| B.S. 1490 L.M.7 .... „ | 216 | 0 | 0 |
| B.S. 1490 L.M.8 .... „ | 203 | 0 | 0 |
| B.S. 1490 L.M.9 .... „ | 203 | 0 | 0 |
| B.S. 1490 L.M.10.... „ | 221 | 0 | 0 |
| B.S. 1490 L.M.11.... „ | 215 | 0 | 0 |
| B.S. 1490 L.M.12.... „ | 223 | 0 | 0 |
| B.S. 1490 L.M.13.... „ | 216 | 0 | 0 |
| B.S. 1490 L.M.14.... „ | 224 | 0 | 0 |
| B.S. 1490 L.M.15.... „ | 210 | 0 | 0 |
| B.S. 1490 L.M.16.... „ | 206 | 0 | 0 |
| B.S. 1490 L.M.18.... „ | 203 | 0 | 0 |
| B.S. 1490 L.M.22.... „ | 210 | 0 | 0 |
| **†Aluminium Alloys (Secondary)** | | | |
| B.S. 1490 L.M.1 .... ton | 153 | 0 | 0 |
| B.S. 1490 L.M.2 .... „ | 163 | 0 | 0 |
| B.S. 1490 L.M.4 .... „ | 178 | 0 | 0 |
| B.S. 1490 L.M.6 .... „ | 189 | 0 | 0 |
| ***Aluminium Bronze** | | | |
| BSS 1400 AB.1..... ton | | — | |
| BSS 1400 AB.2..... „ | | — | |

| *Brass | £ | s. | d. |
|---|---|---|---|
| BSS 1400-B3 65/35 .. ton | | — | |
| BSS 249 ..... „ | | — | |
| BSS 1400-B6 85/15 .. „ | | — | |
| ***Gunmetal** | | | |
| R.C.H. 3/4% ton .... „ | | — | |
| (85/5/5/5) LG2 ..... „ | | — | |
| (86/7/5/2) LG3 ..... „ | | — | |
| (88/10/2/1) ..... „ | | — | |
| (88/10/2/½) ..... „ | | — | |
| ***Manganese Bronze** | | | |
| BSS 1400 HTB1.... „ | | — | |
| BSS 1400 HTB2.... „ | | — | |
| BSS 1400 HTB3.... „ | | — | |
| **Nickel Silver** | | | |
| Casting Quality 12% „ | 220 | 0 | 0 |
| „ „ 16% „ | 225 | 0 | 0 |
| „ „ 18% „ | 240 | 0 | 0 |
| ***Phosphor Bronze** | | | |
| B.S.1400 P.B.1.(A.I.D. released) ..... „ | | — | |
| B.S. 1400 L.P.B.1 .... „ | | — | |

* *Average prices for the last week-end.*

| Phosphor Copper | £ | s. | d. |
|---|---|---|---|
| 10% ..... ton | 253 | 0 | 0 |
| 15% ..... „ | 255 | 10 | 0 |
| **Phosphor Tin** | | | |
| 5% ..... „ | | — | |
| **Silicon Bronze** | | | |
| BSS 1400-SB1 ..... „ | 240 | 0 | 0 |
| **Solder, soft, BSS 219** | | | |
| Grade C Tinmans.... „ | 365 | 15 | 0 |
| Grade D Plumbers.. „ | 293 | 15 | 0 |
| Grade M ..... „ | 401 | 15 | 0 |
| **Solder, Brazing, BSS 1845** | | | |
| Type 8 (Granulated) lb. | | — | |
| Type 9 „ „ | | — | |
| **Zinc Alloys** | | | |
| Mazak III ..... ton | 109 | 2 | 6 |
| Mazak V ..... „ | 113 | 2 | 6 |
| Kayem ..... „ | 119 | 2 | 6 |
| Kayem II ..... „ | 125 | 2 | 6 |
| Sodium-Zinc ..... lb. | | 2 | 6½ |

## Semi-Fabricated Products

Prices vary according to dimensions and quantities. The following are the basis prices for certain specific products

| **Aluminium** | | | |
|---|---|---|---|
| Sheet 10 S.W.G. lb. | 2 | 8½ | |
| Sheet 18 S.W.G. „ | 2 | 10½ | |
| Sheet 24 S.W.G. „ | 3 | 1½ | |
| Strip 10 S.W.G. „ | 2 | 8½ | |
| Strip 18 S.W.G. „ | 2 | 9½ | |
| Strip 24 S.W.G. „ | 2 | 11 | |
| Circles 22 S.W.G. „ | 3 | 2½ | |
| Circles 18 S.W.G. „ | 3 | 1½ | |
| Circles 12 S.W.G. „ | 3 | 0½ | |
| Plate as rolled ..... „ | 2 | 8 | |
| Sections ..... „ | 3 | 2 | |
| Wire 10 S.W.G. .... „ | 2 | 11½ | |
| Tubes 1 in. o.d. 16 S.W.G. ..... „ | 4 | 1 | |
| **Aluminium Alloys** | | | |
| BS1470. HS10W. | | | |
| Sheet 10 S.W.G. „ | 3 | 1 | |
| Sheet 18 S.W.G. „ | 3 | 3½ | |
| Sheet 24 S.W.G. „ | 3 | 11 | |
| Strip 10 S.W.G. „ | 3 | 1 | |
| Strip 18 S.W.G. „ | 3 | 2½ | |
| Strip 24 S.W.G. „ | 3 | 10½ | |
| BS1477. HP30M. | | | |
| Plate as rolled..... „ | 2 | 11 | |
| BS1470. HC15WP. | | | |
| Sheet 10 S.W.G. „ | 3 | 9½ | |
| Sheet 18 S.W.G. „ | 4 | 2 | |
| Sheet 24 S.W.G. „ | 5 | 0½ | |
| Strip 10 S.W.G. „ | 3 | 10½ | |
| Strip 18 S.W.G. „ | 4 | 2 | |
| Strip 24 S.W.G. „ | 4 | 9½ | |
| BS1477. HPC15WP. | | | |
| Plate heat treated.. „ | 3 | 6½ | |
| BS1475. HG10W. | | | |
| Wire 10 S.W.G. „ | 3 | 10½ | |
| BS1471. HT10WP. | | | |
| Tubes 1 in. o.d. 16 S.W.G. ..... „ | 5 | 0½ | |
| BS1476. HE10WP. | | | |
| Sections ..... „ | 3 | 1½ | |
| **Brass** | | | |
| Tubes..... „ | 1 | 10¾ | |
| Brazed Tubes..... „ | 2 | 11¾ | |
| Drawn Strip Sections „ | | — | |
| Sheet ..... ton | 196 | 15 | 0 |
| Strip ..... „ | 196 | 15 | 0 |
| Extruded Bar..... lb. | 2 | 0½ | |
| Extruded Bar (Pure Metal Basis) ..... „ | | — | |

| **Brass** | | | | |
|---|---|---|---|---|
| Condenser Plate (Yellow Metal) ..... | ton | 189 | 0 | 0 |
| Condenser Plate (Naval Brass) ..... | „ | 201 | 0 | 0 |
| Wire ..... | lb. | | 2 | 7⅝ |
| **Beryllium Copper** | | | | |
| Strip ..... | „ | 1 | 4 | 11 |
| Rod..... | „ | 1 | 1 | 6 |
| Wire ..... | „ | 1 | 4 | 9 |
| **Copper** | | | | |
| Tubes ..... | lb. | | 2 | 3½ |
| Sheet ..... | ton | 261 | 10 | 0 |
| Strip ..... | „ | 261 | 10 | 0 |
| Plain Plates ..... | „ | | — | |
| Locomotive Rods .... | „ | | — | |
| H.C. Wire ..... | „ | 282 | 15 | 0 |
| **Cupro Nickel** | | | | |
| Tubes 70/30 ..... | lb. | | 3 | 6⅞ |

| **Lead** | | | | |
|---|---|---|---|---|
| Pipes (London) .... | ton | 111 | 5 | 0 |
| Sheet (London) .... | „ | 109 | 0 | 0 |
| Tellurium Lead .... | „ | £6 extra | | |
| **Nickel Silver** | | | | |
| Sheet and Strip 7% .. | lb. | | 3 | 8 |
| Wire 10% ..... | „ | | 4 | 2½ |
| **Phosphor Bronze** | | | | |
| Wire ..... | „ | | 4 | 1 |
| **Titanium** (1,000 lb. lots) | | | | |
| Billet 4½″ to 18″ dia... | lb. | 54/- | | 55/- |
| Rod ¼″ to 4″ dia. .... | „ | 95/- | | 62/- |
| Wire ·036″ – ·232″ dia. | „ | 167/- | | 110/- |
| Strip ·003″ to ·048″ .. | „ | 200/- | | 75/- |
| Sheet 8′×2′. 20 gauge | „ | 85/- | | |
| Tube, representative average gauge..... | „ | 300/- | | |
| Extrusions ..... | „ | 105/- | | |
| **Zinc** | | | | |
| Sheet ..... | ton | 112 | 5 | 0 |
| Strip ..... | „ | nom. | | |

# Domestic and Foreign

Merchants' average buying prices delivered, per ton, 15/6/59.

| **Aluminium** | £ |
|---|---|
| New Cuttings ..... | 146 |
| Old Rolled ..... | 126 |
| Segregated Turnings ..... | 98 |
| **Brass** | |
| Cuttings ..... | 156 |
| Rod Ends ..... | 144 |
| Heavy Yellow ..... | 121 |
| Light ..... | 117 |
| Rolled ..... | 148 |
| Collected Scrap ..... | 120 |
| Turnings ..... | 137 |
| **Copper** | |
| Wire ..... | 207 |
| Firebox, cut up ..... | 202 |
| Heavy ..... | 198 |
| Light ..... | 193 |
| Cuttings ..... | 207 |
| Turnings ..... | 192 |
| Braziery ..... | 158 |

| **Gunmetal** | £ |
|---|---|
| Gear Wheels ..... | 180 |
| Admiralty..... | 180 |
| Commercial..... | 161 |
| Turnings ..... | 156 |
| **Lead** | |
| Scrap ..... | 59 |
| **Nickel** | |
| Cuttings ..... | — |
| Anodes ..... | 550 |
| **Phosphor Bronze** | |
| Scrap ..... | 161 |
| Turnings ..... | 156 |
| **Zinc** | |
| Remelted ..... | 69 |
| Cuttings ..... | 53 |
| Old Zinc ..... | 37 |

# Metal Statistics

Detailed figures of the consumption and output of non-ferrous metals for the month of April, 1959, have been issued by the British Bureau of Non-Ferrous Metal Statistics, as follows in long tons:—

| COPPER | Gross Weight | Copper Content |
|---|---|---|
| Wire | 20,238 | 19,854 |
| Rods, bars and sections | 14,648 | 9,623 |
| Sheet, strips and plate | 14,430 | 11,448 |
| Tubes | 8,096 | 7,469 |
| Castings and miscellaneous | 7,855 | — |
| Sulphate | 2,863 | — |
| | 68,130 | 55,524 |
| Of which: | | |
| Consumption of Virgin Copper | | 36,124 |
| Consumption of Copper and Alloy Scrap (Copper Content)* | | 11,307 |

| LEAD | |
|---|---|
| Cables | 8,341 |
| Batteries | 2,235 |
| Battery Oxides | 2,257 |
| Tetra Ethyl Lead | 1,524 |
| Other Oxides and Compounds | 2,637 |
| White Lead | 735 |
| Shot | 348 |
| Sheet and Pipe | 6,170 |
| Foil and Collapsible Tubes | 296 |
| Other Rolled and Extruded | 609 |
| Solder | 1,309 |
| Alloys | 1,637 |
| Miscellaneous Uses | 1,104 |
| Total | 29,252 |

| TIN | |
|---|---|
| Tinplate | 810 |
| Tinning: | |
| Copper Wire | 49 |
| Steel Wire | 10 |
| All other | 67 |
| Solder | 166 |
| Alloys | 454 |
| Foil and Collapsible Tubes, etc. | 49 |
| Tin Compounds, Salts, and Miscellaneous Uses | 140 |
| Total Consumption | 1,745 |

| ZINC | |
|---|---|
| Galvanizing | 8,062 |
| Brass | 9,738 |
| Rolled Zinc | 2,074 |
| Zinc Oxide | 2,347 |
| Zinc Die-casting alloy | 3,951 |
| Zinc Dust | 904 |
| Miscellaneous Uses | 930 |
| Total, All Trades | 28,006 |
| Of which: | |
| High purity 99·99 per cent | 4,291 |
| Electrolytic and high grade 99·95 per cent | 5,764 |
| Prime Western, G.O.B. and debased | 10,198 |
| Remelted | 479 |
| Scrap Brass and other Cu alloys | 4,436 |
| Scrap Zinc, alloys and residues | 2,618 |

| ANTIMONY | |
|---|---|
| Batteries | 79 |
| Other Antimonial Lead | 31 |
| Bearings | 30 |
| Oxides—for White Pigments | 151 |
| Oxides—other | 52 |
| Miscellaneous Uses | 18 |
| Sulphides | 3 |
| Total Consumption | 364 |
| **Antimony in Scrap** | |
| For Antimonial Lead | 370 |
| For Other Uses | 34 |
| Total Consumption | 404 |

| CADMIUM | |
|---|---|
| Plating Anodes | 52·35 |
| Plating Salts | 7·35 |
| Alloys: Cadmium Copper | 5·75 |
| Alloys: Other | 3·60 |
| Batteries: Alkaline | 8·30 |
| Batteries: Dry | 0·35 |
| Solder | 5·75 |
| Colours | 23·90 |
| Miscellaneous Uses | 1·55 |
| Total Consumption | 108·90 |

# Scrap Metal Prices

The figures in brackets give the English equivalents in £1 per ton:—

| | | |
|---|---|---|
| **West Germany** (D-marks per 100 kilos): | | |
| Used copper wire | (£210.5.0) | 240 |
| Heavy copper | (£210.5.0) | 240 |
| Light copper | (£183.17.6) | 210 |
| Heavy brass | (£122.15.0) | 140 |
| Light brass | (£92.0.0) | 105 |
| Soft lead scrap | (£57.0.0) | 65 |
| Zinc scrap | (£36.15.0) | 42 |
| Used aluminium unsorted | (£83.5.0) | 95 |
| **France** (francs per kilo): | | |
| Electrolytic copper scrap | (£195.0.0) | 260 |
| Heavy copper | (£195.0.0) | 260 |
| No. 1 copper wire | (£183.15.0) | 245 |
| Light brass | (£112.12.6) | 150 |
| Zinc castings | (£51.0.0) | 68 |
| Lead | (£69.0.0) | 92 |
| Aluminium | (£131.2.6) | 175 |
| **Italy** (lire per kilo): | | |
| Aluminium soft sheet clippings (new) | (£197.12.6) | 335 |
| Aluminium copper alloy | (£126.17.6) | 215 |
| Lead, soft, first quality | (£75.12.6) | 128 |
| Lead, battery plates | (£41.17.6) | 71 |
| Copper, first grade | (£215.10.0) | 365 |
| Copper, second grade | (£203.2.6) | 345 |
| Bronze, first quality machinery | (£200.15.0) | 340 |
| Bronze, commercial gunmetal | (£171.2.6) | 290 |
| Brass, heavy | (£138.15.0) | 235 |
| Brass, light | (£123.17.6) | 210 |
| Brass, bar turnings | (£127.0.0) | 215 |
| New zinc sheet clippings | (£60.2.6) | 102 |
| Old zinc | (£45.10.0) | 77 |

# Financial News

**Minerals Separation**

Group profit, before tax, 1958, £818,717 (£740,975), and dividends 30 per cent on £1·1m. capital (same on £1m. capital), with the 3-for-22 rights offer and 3-for-5 scrip issue. Fixed assets £1,096,370 (£647,215). Quoted investments £2,444,531 (£2,178,987), value £3,512,209 (£2,532,877), and current assets £2,357,734 (£1,708,899). Current liabilities £1,511,077 (£1,061,172). Commitments £37,000.

**The Mint, Birmingham**

Dividend 10 per cent year to March 31, 1959 (7½ per cent and bonus 2½ per cent). Net profit £31,129. Surplus tax £2,239.

**B. O. Morris (Holdings)**

Group net profit year to January 31, 1959, £57,428 (£50,427), after tax £63,322 (£69,709). Add tax adjustments £7,604 (£1,114).

**Canadian Investment**

The board of directors of Chromium Mining and Smelting Corporation has approved capital expenditures amounting to approximately 2,000,000 dollars for the fiscal year ending April 30, 1960. The expenditure would be divided among the Sault Ste. Marie, Ont. Company and its subsidiaries. More than half the money is to be spent at the Corporation's smelter at Memphis, Tenne. Major improvements will be made at the Riverdale, Ill., plant, and capital expenditures made on immediate planned improvements at the Beauharnois, Quebec, plant.

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## *Steady Demand For Steel And Non-Ferrous Metal Shares*

| ISSUED CAPITAL * | AMOUNT OF SHARE | NAME OF COMPANY | MIDDLE PRICE 15 JUNE | +RISE—FALL | DIV. FOR LAST FIN. YEAR | DIV. FOR PREV. YEAR | DIV. YIELD | 1959 HIGH | 1959 LOW | 1958 HIGH | 1958 LOW |
|---|---|---|---|---|---|---|---|---|---|---|---|
| £ | £ | | | | Per cent | Per cent | | | | | |
| 4,435,792 | 1 | Amalgamated Metal Corporation ... | 27/– | | 9 | 9 | 6 3 3 | 27/3 | 23/3 | 24/9 | 17/6 |
| 400,000 | 2/– | Anti-Attrition Metal ... ... ... | 1/3 | | 4 | 8½ | 6 15 0 | 1/6 | 1/3 | 1/9 | 1/3 |
| 41,303,829 | Stk. (£1) | Associated Electrical Industries ... | 60/9 | +1/6 | 15 | 15 | 4 19 3 | 62/– | 54/– | 58/9 | 46/6 |
| 1,613,280 | 1 | Birfield ... ... ... ... ... | 55/6 | +4/3 | 15 | 15 | 5 8 0 | 59/ | 47/– | 62/4½ | 46/3 |
| 3,196,667 | 1 | Birmid Industries ... ... ... | 79/3 | +3d. | 17½ | 17½ | 4 4 0 | 81/9 | 72/– | 77/6 | 55/3 |
| 5,630,344 | Stk. (£1) | Birmingham Small Arms ... ... | 43/4½ | —7½d. | 11 | 10 | 5 1 6 | 44/1½ | 36/1½ | 39/– | 23/9 |
| 203,150 | Stk. (£1) | Ditto Cum. A. Pref. 5% ... ... | 15/6 | | 5 | 5 | 6 9 0 | 16/3 | 15/– | 16/1½ | 14/7½ |
| 350,580 | Stk. (£1) | Ditto Cum. B. Pref. 6% ... ... | 18/10½ | +1/1½ | 6 | 6 | 6 7 0 | 18/10½ | 17/9 | 17/4½ | 16/6 |
| 500,000 | 1 | Bolton (Thos.) & Sons ... ... | 32/6 | | 10 | 10 | 6 3 0 | 32/6 | 27/6 | 28/9 | 24/– |
| 300,000 | 1 | Ditto Pref. 5% ... ... ... | 14/– | —1/3 | 5 | 5 | 7 2 9 | 15/6 | 14/– | 16/– | 15/– |
| 160,000 | 1 | Booth (James) & Co. Cum. Pref. 7% | 20/6 | | 7 | 7 | 6 16 6 | 20/6 | 20/– | 20/4½ | 19/– |
| 1,500,000 | Stk. (£1) | British Aluminium Co. Pref. 6% ... | 19/6 | +3d. | 6 | 6 | 6 3 0 | 19/7½ | 18/9 | 20/– | 18/4½ |
| 17,247,987 | Stk. (£1) | British Insulated Callender's Cables | 54/3 | —1/6 | 12½ | 12½ | 4 12 3 | 56/– | 47/6 | 52/6 | 38/9 |
| 17,047,166 | Stk. (£1) | British Oxygen Co. Ltd., Ord. ... | 60/– | +2/– | 10 | 10 | 3 6 9 | 64/– | 49/3 | 52/– | 28/3 |
| 1,200,000 | Stk. (5/–) | Canning (W.) & Co. ... ... ... | 15/– | —9d. | 25 + *2½C‡ | 25 | 4 3 3 | 32/– | 15/– | 25/3 | 19/3 |
| 60,484 | 1/– | Carr (Chas.) ... ... ... ... | 2/6 | | 12½ | 25 | 5 0 0 | 2/7½ | 1/3 | 2/3 | 1/4½ |
| 150,000 | 2/– | Case (Alfred) & Co. Ltd. ... ...e | 7/3 | | 25 | 25 | 6 18 0 | 7/3 | 4/7½ | 5/3 | 4/– |
| 555,000 | 1 | Clifford (Chas.) Ltd. ... ... | 24/1½ | +6d. | 10 | 10 | 8 5 9 | 24/1½ | 22/6 | 22/– | 16/– |
| 45,000 | 1 | Ditto Cum. Pref. 6% ... ... | 16/– | | 6 | 6 | 7 10 0 | 16/– | 15/3 | 16/– | 15/– |
| 250,000 | 2/– | Coley Metals ... ... ... ... | 3/– | —1½d. | 15 | 20 | 10 0 0 | 4/– | 2/10½ | 4/6 | 2/6 |
| 10,185,696 | 1 | Cons. Zinc Corp.† ... ... ... | 65/6 | —2/– | 15 | 18¾ | 4 11 6 | 68/6 | 60/– | 65/3 | 41/– |
| 1,509,528 | 1 | Davy & United ... ... ... ... | 108/9 | | 20 | 15 | 3 13 6 | 113/9 | 86/– | 87/– | 45/9 |
| 5,830,000 | 5/– | Delta Metal ... ... ... ... | 17/7½ | +1½d. | 31‡ | 30 | 4 8 0 | 33/7½ | 16/3 | 25/– | 17/7½ |
| 5,296,550 | Stk. (£1) | Enfield Rolling Mills Ltd. ... ... | 51/6 | —3/3 | 15 | 12½ | 5 16 6 | 57/6 | 36/7½ | 38/– | 22/9 |
| 750,000 | 1 | Evered & Co. ... ... ... ... | 32/6 | | 10§ | 15 Z | 6 3 0 | 33/3 | 30/– | 30/– | 26/ |
| 18,000,000 | Stk. (£1) | General Electric Co. ... ... ... | 32/3 | —9d. | 10P | 12½ | | 40/3 | 30/6 | 40/6 | 29/6 |
| 1,500,000 | Stk. (10/–) | General Refractories Ltd. ... ... | 36/3 | | 20 | 20 | 5 10 6 | 40/– | 32/6 | 39/3 | 27/3 |
| 401,240 | 1 | Gibbons (Dudley) Ltd. ... ... | 65/– | | 16½ | 15 | 5 1 6 | 66/6 | 63/6 | 67/6 | 61/– |
| 750,000 | 5/– | Glacier Metal Co. Ltd. ... ... | 8/9 | —6d. | 11½ | 11½ | 6 11 6 | 9/3 | 6/7½ | 8/3 | 5/– |
| 1,750,000 | 5/– | Glynwed Tubes ... ... ... ... | 20/– | +6d. | 20 | 20 | 5 0 0 | 20/6 | 16/4½ | 18/1½ | 12/10½ |
| 5,421,049 | 10/– | Goodlass Wall & Lead Industries ... | 38/6 | +9d. | 13‖ | 18Z | 3 7 6 | 38/9 | 28/7½ | 30/9 | 17/3 |
| 342,195 | 1 | Greenwood & Batley ... ... | 87/6 | +3/6 | 20 | 17½ | 4 11 6 | 87/6 | 75/– | 57/9 | 45/– |
| 396,000 | 5/– | Harrison (B'ham) Ord. ... ... | 18/10½ | | *17½ | *15 | 4 12 9 | 19/– | 14/11½ | 15/9 | 11/6 |
| 150,000 | 1 | Ditto Cum. Pref. 7% ... ... | 19/3 | | 7 | 7 | 7 5 6 | — | — | 19/9 | 18/4½ |
| 1,075,167 | 5/– | Heenan Group ... ... ... | 8/– | | 10 | 10‡ | 6 5 0 | 8/6 | 7/6 | 9/7½ | 6/9 |
| 236,958,260 | Stk. (£1) | Imperial Chemical Industries ... | 37/3 | +3d. | 12Z | 10 | 4 6 0 | 38/3 | 33/9 | 38/– | 24/3 |
| 34,736,773 | Stk. (£1) | Ditto Cum. Pref. 5% ... ... | 16/9 | +3d. | 5 | 5 | 5 19 6 | 17/1½ | 16/– | 17/1½ | 16/– |
| 14,584,025 | ** | International Nickel ... ... ... | 171 | +5½ | $2.60 | $3.75 | 2 14 3 | 171 | 153 | 169 | 132½ |
| 860,000 | 5/– | Jenks (E. P.). Ltd. ... ... ... | 16/9 | +4½d. | 14 | 27½φ | 4 3 6 | 17/6 | 8/9 | 10/– | 6/7½ |
| 300,000 | 1 | Johnson, Matthey & Co. Cum. Pref. 5% | 16/3 | | 5 | 5 | 6 3 0 | 16/3 | 15/4½ | 16/9 | 15/– |
| 3,987,435 | 1 | Ditto Ord ... ... ... ... | 61/– | | 10 | 10 | 3 5 6 | 61/– | 44/3 | 47/– | 36/6 |
| 600,000 | 10/– | Keith, Blackman ... ... ... | 30/– | | 17½E | 15 | 5 16 9 | 30/– | 25/– | 28/9 | 15/– |
| 320,000 | 4/– | London Aluminium ... ... ... | 5/9 | | 10 | 10 | 6 19 3 | 6/4½ | 5/3 | 6/– | 3/– |
| 765,012 | 1 | McKechnie Brothers Ord. ... ... | 41/3 | | 15 | 15 | 7 5 6 | 45/– | 41/3 | 45/– | 32/– |
| 1,530,024 | 1 | Ditto A Ord. ... ... ... | 39/3 | | 15 | 15 | 7 12 9 | 43/6 | 38/9 | 45/– | 30/– |
| 1,108,268 | 5/– | Manganese Bronze & Brass ... ... | 15/3 | +4½d. | 20⅝ | 20 | 6 16 6 | 16/3 | 13/9 | 14/1½ | 8/9 |
| 50,628 | 6/– | Ditto (7½% N.C. Pref.) ... ... | 6/– | | 7½ | 7½ | 7 10 0 | — | — | 6/3 | 5/6 |
| 13,098,855 | Stk (£1) | Metal Box ... ... ... ... | 85/3 | —6d. | 11 | 11 | 2 11 9 | 85/9 | 66/6 | 73/3 | 40/6 |
| 415,760 | Stk. (2/–) | Metal Traders ... ... ... ... | 10/3 | | 50 | 50 | 9 15 0 | 10/3 | 8/4½ | 9/– | 6/3 |
| 160,000 | 1 | Mint (The) Birmingham ... ... | 25/– | | 10 | 10 | 8 0 0 | 25/– | 22/– | 22/9 | 19/– |
| 80,000 | 5 | Ditto Pref. 6% ... ... ... | 73/– | | 6 | 6 | 8 4 6 | 75/6 | 69/– | 83/6 | 69/– |
| 3,705,670 | Stk. (£1) | Morgan Crucible A ... ... ... | 49/– | —9d. | 10 | 10 | 4 1 9 | 49/9 | 43/6 | 45/– | 34/– |
| 1,000,000 | Stk. (£1) | Ditto 5½% Cum. 1st Pref. ... | 17/6 | | 5½ | 5½ | 6 5 9 | 18/6 | 17/6 | 18/– | 17/– |
| 2,200,000 | Stk. (£1) | Murex ... ... ... ... ... | 42/6 | +6d. | 17½ | 20 | 8 4 9 | 50/– | 42/– | 58/9 | 46/– |
| 468,000 | 5/– | Ratcliffs (Great Bridge) ... ... | 10/– | +1½d. | 10R | 10 | 3 15 0 | 11/6 | 9/6 | 11/1½ | 6/10½ |
| 234,960 | 10/– | Sanderson Bros. & Newbould ... | 36/– | | 25 | 20 | 6 19 0 | 37/– | 27/9 | 27/3 | 24/6 |
| 1,365,000 | Stk. (5/–) | Serck ... ... ... ... ... | 20/– | +3d. | 15 | 17½ | 3 15 0 | 21/– | 18/– | 18/7½ | 11/– |
| 6,698,586 | Stk. (£1) | Stone-Platt Industries ... ... | 49/– | —9d. | 15 | 15 | 6 2 6 | 53/6 | 43/3 | 45/6 | 22/6 |
| 2 928,963 | Stk. (£1) | Ditto 5½% Cum. Pref. ... ... | 17/3 | | 5½ | 5½ | 6 7 6 | 17/6 | 15/10½ | 16/3 | 12/7½ |
| 18,255,218 | Stk. (£1) | Tube Investments Ord ... ... | 89/6 | +3/9 | 17½ | 15 | 3 18 3 | 89/6 | 72/– | 86/– | 48/4½ |
| 41,000,000 | Stk. (£1) | Vickers ... ... ... ... | 31/3 | +1/6 | 10 | 10 | 6 8 6 | 37/– | 29/9 | 36/3 | 28/9 |
| 750,000 | Stk. (£1) | Ditto Pref. 5% ... ... ... | 14/3 | | 5 | 5 | 7 0 3 | 15/0½ | 14/3 | 15/9 | 14/3 |
| 6,863,807 | Stk. (£1) | Ditto Pref. 5% tax free ... ... | 20/6 | —9d. | *5 | *5 | 7 10 6A | 22/7½ | 20/6 | 23/– | 21/3 |
| 2,200,000 | 1 | Ward (Thos W.), Ord ... ... | 95/– | —3d. | 20 | 15 | 4 3 9 | 95/3 | 83/6 | 87/3 | 70/9 |
| 2,666,034 | Stk (£1) | Westinghouse Brake ... ... ... | 42/– | | 10 | 10 | 4 15 3 | 47/– | 39/9 | 46/6 | 32/6 |
| 225,000 | 2/– | Wolverhampton Die-Casting ... | 9/6 | +3d. | 30 | 25 | 6 6 3 | 10/6 | 8/8½ | 10/1½ | 7/– |
| $91,000 | 5/– | Wolverhampton Metal ... ... | 30/10½ | +7½d. | 27½ | 27½ | 4 7 0 | 30/10½ | 21/6 | 22/9 | 14/9 |
| 78,465 | 2/6 | Wright, Bindley & Gell ... ... | 6/9 | +1½d. | 20 | 20 | 7 8 3 | 6/9 | 4/11½ | 5/4½ | 2/9 |
| 124,140 | 1 | Ditto Cum. Pref. 6% ... ... | 13/9 | | 6 | 6 | 8 14 6 | 13/9 | 13/6 | 13/– | 11/3 |
| 150,000 | 1/– | Zinc Alloy Rust Proof ... ... | 3/3 | | 27 | 40D | 9 0 0 | 3/3 | 2/9 | 3/1½ | 2/7½ |

*Dividend paid free of Income Tax. †Incorporating Zinc Corpn. & Imperial Smelting. **Shares of no Par Value. ‡ and 100% Capitalized issue. ● The figures given relate to the issue quoted in the third column. A Calculated on £7 14 6 gross. Y Calculated on 11½% dividend. ‖Adjusted to allow for capitalization issue. E for 15 months. D and 50% capitalized issue. Z and 50% capitalized issue. B equivalent to 12½% on existing Ordinary Capital after 100% capitalized issue. φ And 100% capitalized issue. X Calculated on 17½%. C Paid out of Capital Profits. E and 50% capitalized issue in 7% 2nd Pref. Shares. P Interim dividend since reduced. § And Special distribution of 2½% free of tax. R And 33⅓% capitalized issue in 8% Maximum Ordinary 5/- Stock Units.

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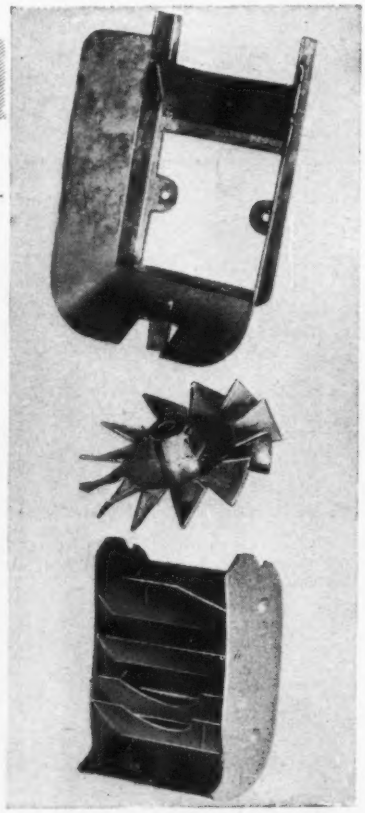

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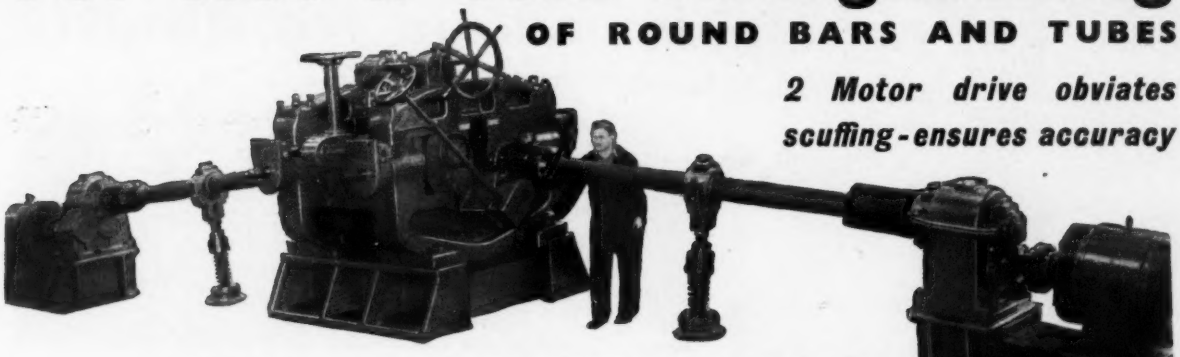

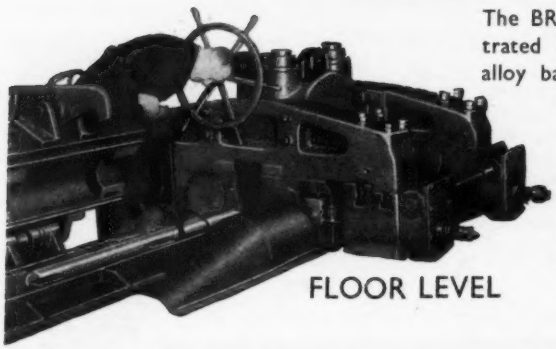

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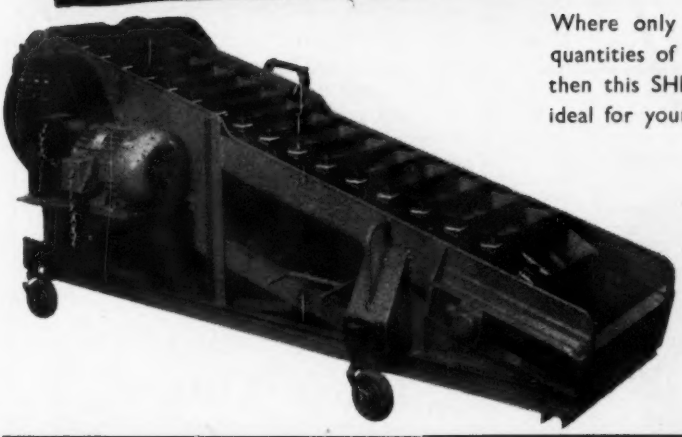

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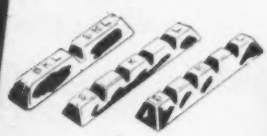

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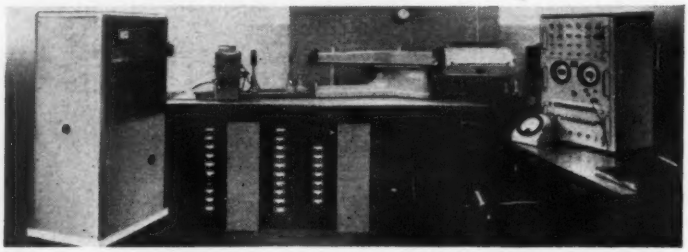

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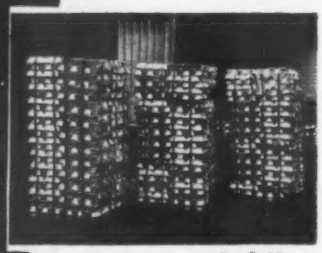

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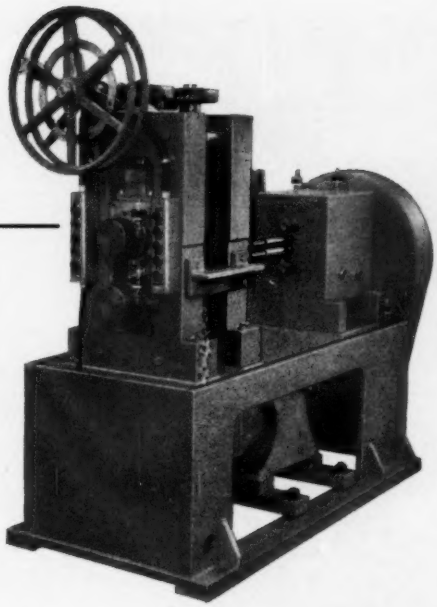

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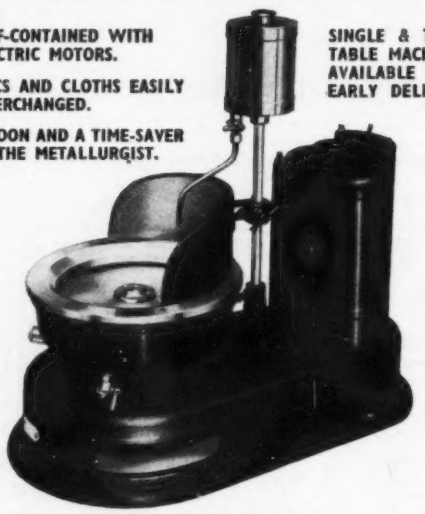

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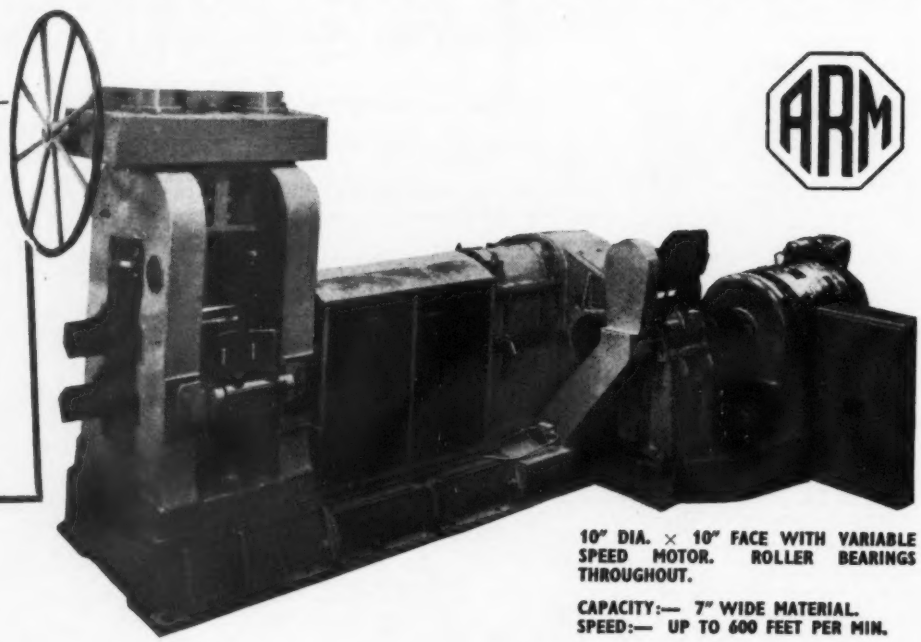

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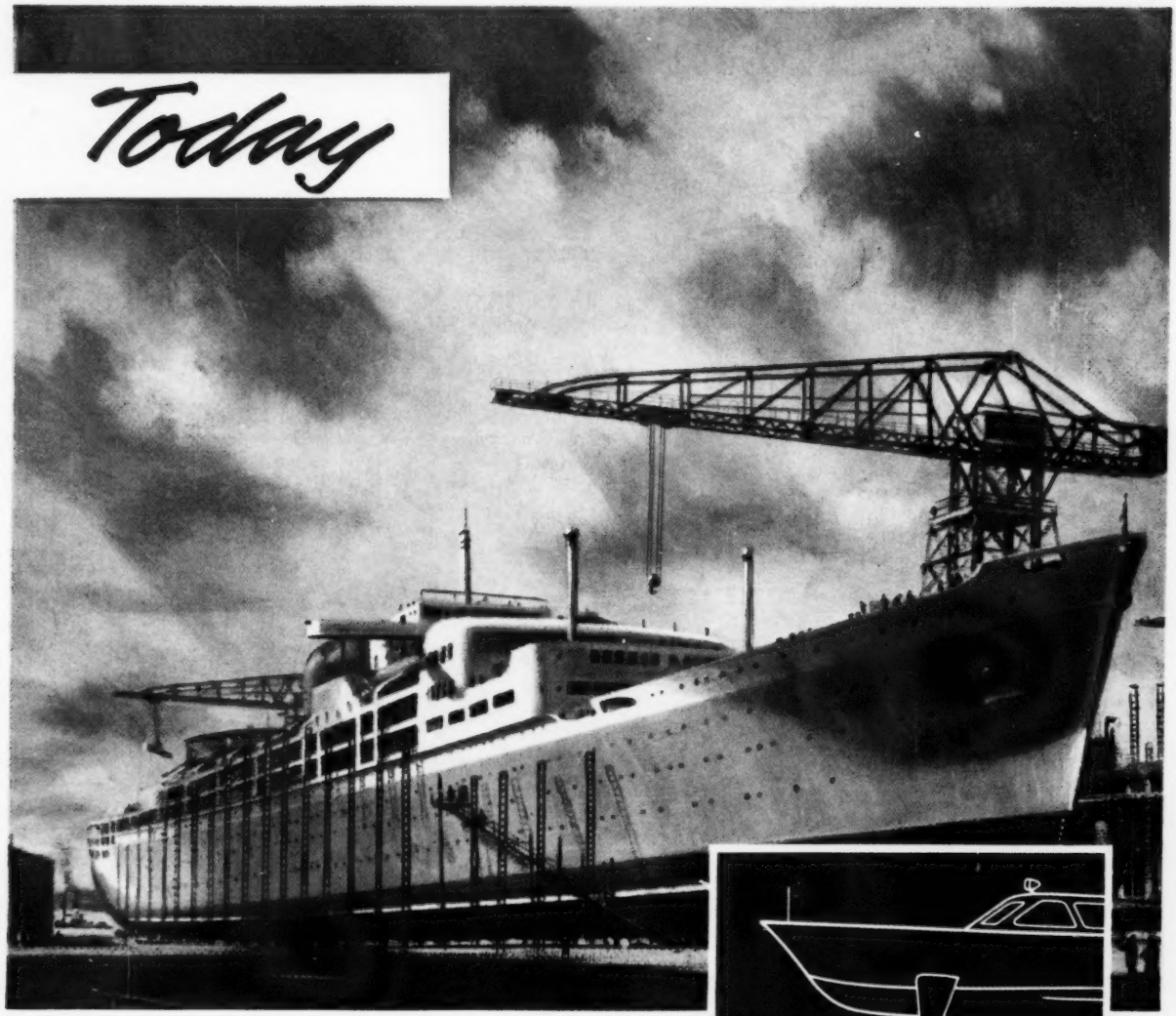
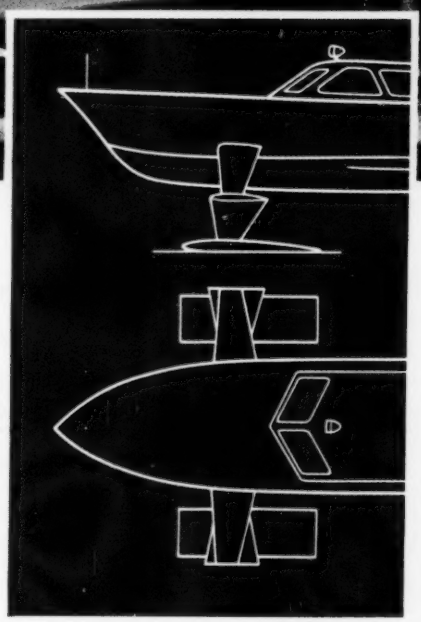
# *Today*





# *Tomorrow*

British industries will benefit from today's investigations into new sources of gas – small coal, oil, refinery gases, methane drained from mines and imported liquefied gas – so that tomorrow's gas will be even more preferred as an industrial fuel for economic production . . . . . **AND TODAY** – every industry and 12 million homes use **GAS.**

ISSUED BY THE GAS COUNCIL

A.5/3

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